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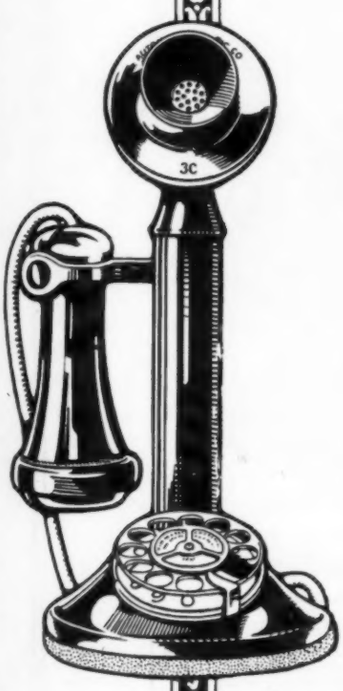
TELEPHONE ENGINEER

VOLUME 28 MAY, 1924 NUMBER 5



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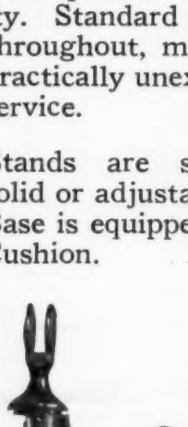

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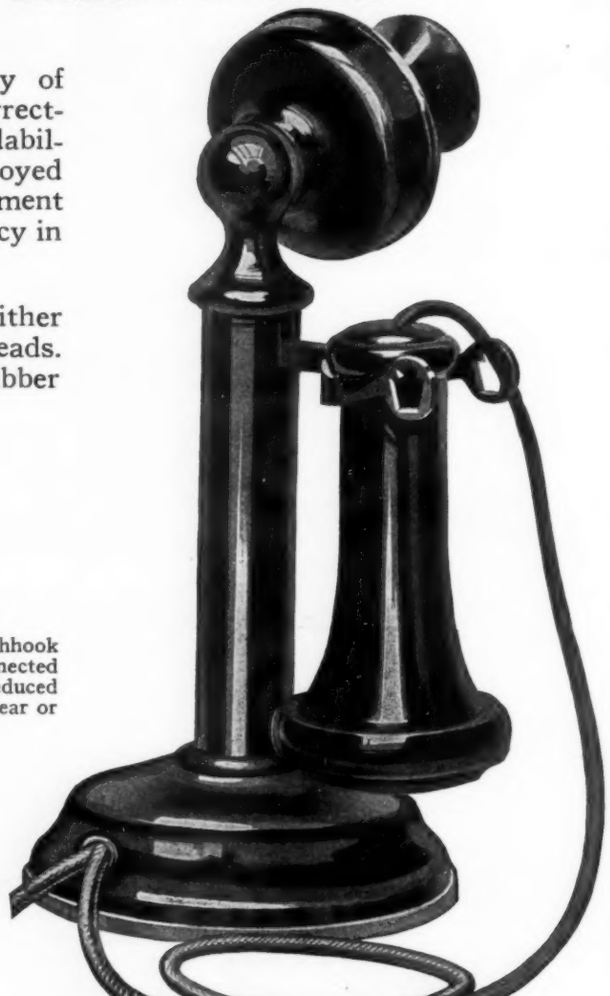

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THE RADIO ANTENNA HAZARD

One of the problems for the telephone companies that has developed out of the radio-broadcast-listening craze is the hazard that arises from antenna construction. This is not imaginary, as is shown by the frequent news notices of deaths and injuries due to crossing of radio antennas and high voltage wires.

The average radio antenna is put up with little or no regard for safety—a light copper or iron wire, tied insecurely to a couple of flimsy insulators which are tied equally insecurely to a convenient telephone pole, tree, chimney or any other structure that may be handy. Every windstorm takes its toll of these jerry-built antennas.

Here is where the problem affects telephone companies. Many of these antennas cross over telephone wires and primary circuits of the electric companies. The insulator or the wire of the antenna breaks, the wire falls down on the telephone and electric wires and the voltage of the electric wires is placed on the telephone circuits. A telephone subscriber goes to use the telephone and receives a severe shock or, perhaps, is killed by the electric current.

Suit is brought and the telephone company is made a joint defendant. Even if it can prove that it has not been negligent and that it has no responsibility for the accident, it has the trouble and expense of defending the suit.

Some telephone companies have made no effort to prevent the attaching of antennas to their poles. Others have refused to allow such attachments. Neither policy, however, solves the problem, as the antenna which crosses over the line rather than the one attached to the telephone pole is the one that causes trouble. Probably the only remedy is the passage and enforcement of city ordinances requiring substantial construction of all outdoor antennas.

THE AGE OF THE EQUIPMENT ENGINEER

A few years ago, the engineering of the outside plant was the most prominent phase of the engineering work of the operating telephone company. Representing considerably more than one-half of the total plant investment, the outside plant required careful planning if it was to be operated and expanded in an economical manner. On the other hand, equipment of the central office was fairly well standardized in the form of the common battery, manual switchboard. Additional offices were installed infrequently and additions to individual offices were made only at intervals of several years. As a rule, the operating companies did little of the detail engineering of the switchboards and additions, other than to specify the size, type, number of positions, number of lines and to furnish floor plans.

On account of this condition, most of the companies had reasonably adequate staffs of outside plant engineers, but, even in some of the large companies, equipment engineering staffs were very limited in numbers and in experience, while among the smaller companies there was scarcely one which had an equipment engineer. Engineering information, upon which could be based an intelligent study of the type, the size, and the arrangement of plant for most economical operation in the long run, existed about in the same proportion as the size of the engineering staffs. As a result, when an addition to the outside plant was to be made, alternative plans were studied and before a decision was made, the plan adopted was subjected to the acid test: "Will it prove in?" Studies of equipment additions were not made with the same thoroughness, due in part to the scarcity of information and to the scarcity of available types of equipment.

Due to the increasing popularity of the automatic method of operation and to the development of labor-saving features on manual switchboards, the type of equipment in the modern exchange is not limited to the single type of common battery manual switchboards. Mechanical switching of the panel type and the step-by-step type; semi-mechanical; manual switchboards with and without machine ringing and other features have to be considered. The inventive fertility of equipment engineers for manufacturing companies has placed upon their brother engineers of the operating companies the burden of acquiring increased knowledge of switching functions and switching apparatus.

There are reasons to fear that the operating engineers have not always accepted this burden in a manner that served the best interests of their companies. Too frequently, decisions have been made after a superficial study, based largely upon data supplied by the manufacturing companies. This is not intended to be a reflection upon the engineers of the

manufacturing companies, but it is a fact that the engineering of equipment frequently has been too much influenced by the viewpoint of the manufacturer. This is only natural, as the manufacturing and designing engineers have been deprived of something to which they, in justice, were entitled, namely, the viewpoint of well informed operating engineers.

Operating telephone companies owe it to themselves, to their subscribers and to telephone manufacturers to develop more and better equipment engineers. They must develop men who can analyze switching functions, who can translate these functions into terms of the proper apparatus for performing them, and who can determine what methods of switching are best suited to particular circumstances. Information must be collected and distributed and decisions must be tested by the laws of engineering economics, just as decisions are now tested by these laws in the engineering of the outside plant. The equipment engineer today is lagging behind the outside plant engineer in this respect, but the condition will probably correct itself rapidly. The engineering of equipment will at no distant date be placed on the same sound economic basis as outside plant engineering is today.

THE TELEPHONE LIBRARY IS GROWING

About a year ago, a comment appeared in these columns calling attention to the scarcity of technical books in the telephone field. To a certain extent this situation has been relieved as far as general works are concerned. With the recent publication of "Telephony, Including Automatic Switching," by Arthur Bessey Smith (reviewed in another column) to serve as an introductory work; with the five-volume series on "Principles and Practice of Telephony" by Jay G. Mitchell available for those who wish to follow their studies to a more complete understanding of detailed principles of various apparatus and circuit elements and the McMeen and Miller "Telephony" in its revised edition for still more advanced students, we now have quite a complete series of texts available for study by the ambitious telephone man or the technical student.

There is still a great lack of publications in special fields, however. Dr. Kennelly's book on Electrical Vibration Instruments gives a satisfactory treatment of the receiver and the automatic telephone field has been pretty well covered but other branches still offer opportunities for publication of monographs. There is certainly a place for a book devoted exclusively to telephone cable practice. A treatise on telephonic transmission viewed from the practical rather than the mathematical standpoint would be welcomed by many telephone engineers. There are instruction books on operating practice but there is no published work dealing with the principles underlying telephone traffic beyond a casual chapter or two in some of the general works. In other departments the literature is equally scant.

In each of these departments there are many men who are capable of writing an authoritative work but they are apparently so busy that they will not undertake the rather laborious task of preparing a book. It is to be hoped, however, that the future will bring forth some of these much needed monographs.

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ORGANIZATION OF CLASS "A" COMPANIES

The organization of the Independent Class "A" companies, which fast is being perfected, and the organization of lower class companies which is expected to follow, mark a distinct step in telephone association history. Independent telephone men are coming to realize that there is such a thing as too much independence when this independence means that each company follows its own experience and fails to benefit from the experience of its neighbor companies. The formation of engineering, accounting and other committees will provide a clearing house for the interchange of information and ideas, and we predict that the time is not far distant when the Independent telephone industry will have a full fledged general staff.

USE OF TREATED POLES IS IMPORTANT

When additions to outside plant are being planned, one point should not be overlooked: This is the economic necessity of using treated pole timber. Pole timber is already scarce and the prices are high. There is no assurance that further supplies will be available when the present poles have reached the end of their life. The additional life obtained by the use of adequate preservative treatment not only pays the cost in the long run, but also aids greatly in the conservation of our national resources which is becoming a patriotic duty.

The Telephone Pole Line

Fittings, Setting of Poles, Guying, Weight and Strength of Wire, Factors Affecting Pole Lines, Insulator Facts —Stringing the Line—Collection of Valuable Pole Data

By P. Kerr Higgins

In order that maintenance cost may be kept low and service interruptions reduced to a minimum well built telephone pole lines for city, town and country use are absolutely necessary. One of the first essentials of a good pole line is good material and the selection of good poles is very important. Only poles cut from live and growing timber should be accepted. They should be peeled; knots should be trimmed close; and butts and tops sawed square. The tops must be sound and the pole should have a good taper so that the butt is large enough to give adequate strength.

No pole should have more than one crook, and this in one way only. The sweep should not exceed one inch for every six feet in length. The sweep is measured by placing a tape at the center of the top and stretching it to the center of the butt, the distance from the tape to the nearest side of the pole at its widest point gives the amount of sweep.

Several varieties of wood are used, such as red or white cedar, chestnut, treated pine, juniper, cypress, etc. The majority of poles used are of the cedar and is probably the best all around pole for telephone purposes, although recently treated pine has become very popular. Other poles are used where a local supply of the timber make them economical. The only objection to the treated pine is the injury to the lineman's hands and clothing.

The life of a pole depends upon the wood and upon the nature of the soil in which it is placed. Cedar poles have an average life of twenty years, untreated pine poles, about nine years, and spruce about five years. This gives some idea of the relative useful life of these poles. It is true the writer has seen mountain cedar poles which have been in use twenty-five years without any indications of decay, but we are speaking of averages in the above figures. Where the butts or the entire pole are treated, it has been found that the life of the pole is increased from five to fifteen years.

It is common practice to roof or chamfer the top of each pole to an angle of forty-five degrees before it is placed. It is also customary to cut one or more gains for cross arms on the pole and paint the gains and top with creosote or white lead before placing.

Something About Pole Fittings

Cross arms are made in sizes from two to twelve pin according to requirements and are usually of fir or pine. Cross arms should be rounded at the top to shed water and bored for locust pins according to specifications or requirements as to size. It is customary to space the pins ten or twelve inches apart except at the center, where sixteen inches is used to permit passage of the pole. There should be four inches between the last pin and the end of the cross arm. Duplex pins have been sometimes used, but have not become popular. Brackets are used

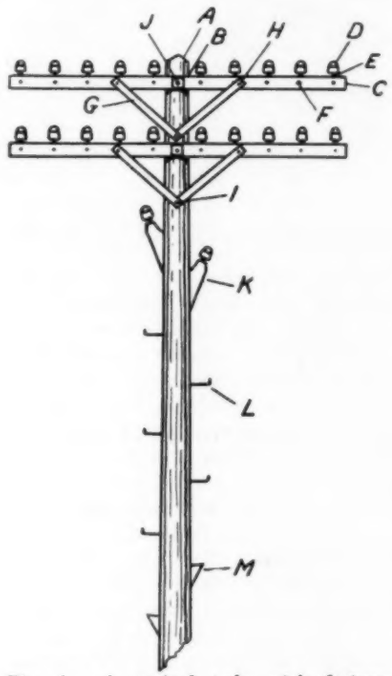

Fig. 1. A typical pole with fittings: A—Roof; B—Gain; C—Cross Arm; D—Insulators; E—Pin; F—Nail; G—Brace; H—Carriage Bolt; I—Lag Screw; J—Through Bolt; K—Bracket; L—Iron Step; M—Wood Step

where a cross arm is not justified. Each pin of the cross arm should be held in its hole by a wire nail driven through the cross arm and pin. Each cross arm is attached to the pole by means of a through bolt of the required length and size. Attached to the cross arms are two braces, which are fastened to the arm with carriage bolts. Both the braces are brought together on the pole and fastened with a lag screw. The distance between cross arms is usually two feet. At crossings it is good construction to use double cross arms.

On all city poles and on test and terminal poles, it is customary to use iron pole steps staggered twenty-four inches between centers. These steps begin at a point about ten feet from the ground; below that sawed off brackets or wood steps are used. All of the material described above are known as the pole fittings and a pole with all the usual fittings is illustrated in Fig. 1.

Some of the things that happen as a result of using a poor grade of poles, of over loading them or leaving untreated, poles in service after the butts are decayed, are shown in Fig. 2.

Suggestions for Setting Poles

In regard to the setting of poles, no definite rule can be given as to the proper depth as this will vary according to soil conditions, height and weight of poles and the load to be carried. As a general rule, however, the depth will run all the way from three and a half to seven feet, being one-half foot greater at curves and corners than on straight line. It is not necessary to describe the setting of poles by the use of pike poles as this is familiar to all telephone men. In filling up the holes around the pole the dirt should be banked up around the pole to a height of about one foot after the dirt needed to fill the hole is well tamped. The distance between poles varies from one hundred to one hundred and fifty feet according to prevailing conditions. If the poles are set in loose soil, the distance between poles should be decreased, also at curves, and in open country where little or no protection is afforded from wind and storm and the lead carries one ten pin cross arm or more. A good average farm line has thirty-five poles per mile and from forty to forty-five on the turns.

In setting poles, care should be taken to turn them so that where the line runs straight the cross arm will be at right angles to the direction of the line and the poles should be turned so that the arms on alternate poles face each

other. At curves, the cross arms should bisect the angle to be formed by the wires. All poles should be raked against the strain, especially at corners and on curves.

Good Corners Require Good Guying

The test of a good construction man is the manner in which his corners and curves are built, because these are the foundation of every telephone line.

Fig. 2. Reaping the whirlwind. Poor poles, over-loading, lack of inspection, are preventable causes

Previous to stringing the wires, whatever bracing, raking or guying of the poles is needed should be completed. The efficiency of a brace or guy depends to a great extent upon its position relative to that of the pole. The acute or inside angle formed by the poles should be halved by a brace. When a guy is used the obtuse or outside angle formed by the poles should be halved. This is shown graphically in Fig. 3. To select the proper point on the pole at which a brace will exert the proper pressure requires some knowledge of mechanics, and as conditions vary greatly no iron-clad rule may be given. However, the angle between the pole and brace should increase in proportion to the curve angle formed by the pole or line. If the guy or the top of the brace is placed too far below the top of the pole the guy or brace will become a fulcrum for a leverlike action of the pole when tension is exerted at the cross arm. This is shown in Fig. 4.

Guys fastened to trees are sometimes employed in rural construction, especially on light lines. When this is done, the heaviest tree should be selected and the guy located at a point where the minimum vibration exists, consistent with a proper clearance of the roadway, etc. If it is necessary to wrap the wire around the tree in order to fasten it properly, strips of wood should be placed next to the bark to keep the wire from injuring the tree. While tree guys are permissible occasionally, the best practice is to anchor in the ground. If the line is a light one, the patent anchor can be used to good advantage. When this is not possible or practical, the log anchor is used. In making ground anchors a large piece of wood or railroad tie or the butt of a pole is used, having bolted to it at right angles an iron rod terminating in a ring, eyelet or a loop with a thimble enclosed. Such a log must be buried several feet below the surface, and in such a way that the anchor rod inclines in the direction intended

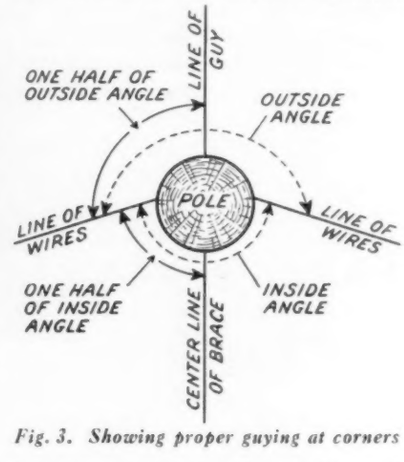

Fig. 3. Showing proper guying at corners

for the guy wire. The anchor rod passes through a hole bored in the log and four by four galvanized iron washers are used to prevent the nuts from pulling through the work. All guys and corners should be strong enough so that the supported wires or cables will break before the guys or supports will fail.

Practically all materials are elastic up to a certain point commonly called the elastic limit. Having reached this the material sets permanently. If the load is then further increased until the material snaps, the point at which it gives way is known as the "breaking point." Guy or messenger wire strand may be specified by its breaking strength as so many thousand pounds or by its diameter. The following table gives wire weights and breaking strengths of ordinary steel guy strand:

Size; B.W.G. Single Wire.	Weight per mile.	Breaking Strength.
6	590 lbs.	1,960 lbs.
10	258 lbs.	860 lbs.
12	170 lbs.	566 lbs.
14	99 lbs.	330 lbs.

Stranded.	Number of wires to give equal strength. No. 10	No. 12	No. 14	
1/2 in.	10	15	26	8,500 lbs.
7/16 in.	7	11	20	6,500 lbs.
3/8 in.	6	9	15	5,000 lbs.
5/16 in.	4	7	11	3,800 lbs.

A special steel known as Sieman's steel is made which has a higher breaking strength than that given above. In considering the strength of material, we should remember that ordinary BB iron wire has a breaking strength of approximately three and one-third times its weight per mile. The ultimate breaking strengths and elastic limits of both hard drawn copper and soft iron wire are about the same, namely 60,000 pounds per square inch for the breaking strength and half of that amount for the elastic limit. The table above showing the breaking strengths of stranded wire applies only to the ordinary kind. Special high strength stranded wire is made which will carry from two to three times the loads indicated. These special strands are made up of steel having a higher carbon content and are harder and stiffer and much more difficult to handle than the ordinary strand. It has been reported that these hard steels are more subject to corrosion.

In referring to guying one hears the angle of repose mentioned frequently

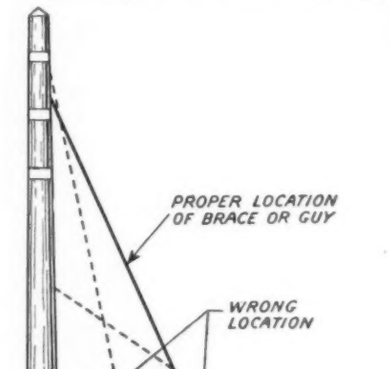

Fig. 4. Showing proper and improper methods of guying

This refers to a pile of material stacked as high as it is possible to stack it. The sides of the pile will then assume an angle at which the material will remain at rest. This angle is known as the angle of repose and differs for various kinds of materials and soils. An anchor placed at a certain depth in the earth will at least hold a load equal to the weight of a prism of soil formed by the foot of the anchor and the angle

of repose, for the soil in which the anchor is located. The customary angle in such cases is 45°. It is well to remember that the holding power of an anchor increases as the cube of the depth, for breadth, width and depth all increase in proportion to an increase in depth.

Other Factors Affecting Strength of Line

In addition to breaking strength (in building a pole line) we have to consider wind and its effects on the wire and fixtures. For many years it was the practice to use very high poles, but in later years the practice has been to use the lowest poles possible under the circumstances. Pole lines should be kept as low as is consistent with the conditions governing but, of course, high enough for proper clearance and to keep the wires from being tampered with. This is advisable because the wear and tear on the low pole line is much less and the original cost of the pole line is also reduced. Three things must be contended with in maintaining a pole line. 1, wind; 2, sleet (or ice); 3, temperature. Wind stresses increase in direct proportion to the length of the pole. This can be proved mathematically. The friction of the earth's surface acts as a wind break, so that the higher the poles, the greater the wind velocities to which they are exposed. In addition to the wind pressure we have to consider line or conductor stresses. These are due to the weights of the conductor or cable used. This load or stress varies inversely as the sag of the wire and the load increases as the square of the length of the span between poles. This load may be found by the use of a graphical method or a formula used in finding the various loads and stresses might be given, but it is too complicated for the average reader. If necessary this method of computing loads can be found in text books on the subject.

A saving in construction cost can be made if the required number of cross arms or brackets are put on before setting the pole.

Some Facts About Insulators

As a general rule insulators for telephone lines are made of glass and are rather small and light. In the rural districts and on toll lines, the telephone company is at the mercy of school children, boys with rifles and hunters who cause considerable damage and breakage. In many rural districts it has been found almost impossible to keep glass insulators on the pole lines. In cases of this kind porcelain insulators have been tried with considerable success and even these are frequently smashed with bullets and rocks. About two years ago, a new type of insulator was patented which has a metal base over which is baked a heavy coating of enamel. Tests made with this insulator has demonstrated that it has many features to recommend it as far as strength is concerned, but high insulation resistance cannot be expected. Ordinarily glass is the preferred insulation because of its transparency which has a tendency to keep spiders, caterpillars, etc., from spinning their webs or cocoons underneath, thereby lowering the insulation.

Tem. Degrees Fahrenheit	Lengths of Span in Feet					
	75	100	115	130	150	200
— 30	1	2	2½	3½	4½	8
— 10	1¼	2½	3	3¾	5	9
10	1½	2¾	3½	4½	5¾	10¼
30	1¾	3	4	5¼	6¾	12
60	2½	4¼	5½	7	9	15½
80	3¼	5½	7	8½	11¼	18¾
100	4¼	7	9	11	14	22¾

Pole Data and Stringing the Line

The author has accumulated a considerable amount of pole data which he has found to be very useful. This is presented in the accompanying tables, most of which are self explanatory and require no discussion here.

Telephone wires are usually erected by mounting the payout reels containing the coil of wire upon a wagon or automobile and as this is driven along beside the poles, the wires are raised and tied in to the insulators. Where this cannot be done a man is left in charge of the payout reel and another man takes the wire and passes it over the cross-arms until he has expended the coil which usually contains about one-half mile of wire. The tying in, if any done at this time is what is known as "loose tie," which permits the wire to be drawn through the tie until the proper tension has been secured. As a general rule, however, the tension is first applied and then the wires are tied in. To secure the proper tension a pair of small blocks, come-alongs or jack straps are used. The come-along is provided with an eccentric clamp which grips the wire, when tension is applied. The blocks, differential pulley or strap exerts the necessary tension. When the wires are pulled to the proper tension, the fact is usually noted by observing the dip or sag of the wire. By dip or sag is meant the distance between the lowest part of the wire and a straight line joining its two points of support. The usual method for determining this distance is by sighting along corresponding points on the two insulators or cross arms.

The proper dip depends upon the length of the span between poles and the atmospheric temperature at the time of stringing the line. Hence, if wires are strung in the summer time a greater dip should be allowed than if done in winter; otherwise the contraction of the conductors caused by the cold weather is liable to break them. The longer the span the greater the weight to be supported, consequently the greater the strain, and so the dip must be increased as indicated in the following table:

The tying in of wire is a very important matter and must be done very carefully, especially on hard drawn copper wire. The following is one method of doing this: The conductor is placed in the groove of the insulator and the tie wire is passed around the insulator in the groove. One end of the tie wire is then drawn under the other and over the wire, crossed and tightly twisted four or five times around the conductor. In dead ending copper line wire, the ends may be made up in a copper sleeve. In using the sleeve, the line wire is cut and passed through one of the tubes, then around the groove in the insulator and back through the remaining tube of the sleeve. The sleeve is then twisted with copper connectors, the one tube over the other throughout their entire length and a firm joint is thus thereby secured. In splicing, the two wires to be spliced are passed through their respective tubes in opposite directions and each end bent up slightly at the distant end of its tube. The required number of twists are then made with copper connectors and the splice is finished. The above brief survey of construction seems rather simple and really is simple when a very light line is desired, but as the load factor is increased the complications pertaining to the line also increase and it may be necessary to give some further consideration to this matter at another time.

Some practical tables supplementary to Mr. Higgins' article appear on the page facing.

TABLE I
DIMENSIONS OF CHESTNUT POLES

Class	"A" 50, 60, 70 or 80 wire line 6 feet from top butt		"B" Heavy trunk line 6 feet from top butt		"C" Light trunk line 6 feet from top butt		"D" Light line 6 feet from top butt		"E" Branch line 6 feet from top butt	
Length of poles, feet										
20	..	..	..	..	..	..	..	..	..	..
22	..	..	..	..	..	..	..	..	15½	23
25	..	..	..	..	20	30	20	27	15½	24
30	24	40	22	36	20	33	20	31	15½	26
35	24	43	22	40	20	36	20	35	15½	29
40	24	45	22	43	20	40	20	39	20	34
45	24	48	22	47	20	43	20	43	20	38
50	24	51	22	50	20	46	20	46	20	42
55	22	54	22	53	20	49	..	..	20	46
60	22	57	22	56	..	..	..	..	..	..
65	22	60	22	59	..	..	..	..	..	..
70	22	63	22	62	..	..	..	..	..	..
75	22	66	22	65	..	..	..	..	..	..
80	22	70	22	69	..	..	..	..	..	..
85	22	73	22	72	..	..	..	..	..	..
90	22	76	22	75	..	..	..	..	..	..

TABLE II
DIMENSIONS OF WHITE CEDAR POLES—SINGLE CARS

Size pole	Estimated weight	No. per load
4 -inch top, 16 feet	80 pounds each	From 300 to 500
5 -inch top, 16 feet	100 pounds each	From 240 to 520
4 -inch top, 18 feet	90 pounds each	From 265 to 465
5 -inch top, 18 feet	120 pounds each	From 200 to 350
4 -inch top, 20 feet	100 pounds each	From 240 to 420
5 -inch top, 20 feet	130 pounds each	From 185 to 325
6 -inch top, 20 feet	175 pounds each	From 137 to 250
7 -inch top, 25 feet	210 pounds each	From 115 to 200
4 -inch top, 25 feet	150 pounds each	From 160 to 280
5 -inch top, 25 feet	200 pounds each	From 120 to 210
5½-inch top, 25 feet	225 pounds each	From 110 to 190
6 -inch top, 25 feet	250 pounds each	From 100 to 170
6½-inch top, 30 feet	400 pounds each	From 60 to 105
7 -inch top, 25 feet	350 pounds each	From 70 to 130
8 -inch top, 25 feet	400 pounds each	From 60 to 105
5 -inch top, 30 feet	275 pounds each	From 80 to 155
6 -inch top, 30 feet	350 pounds each	From 70 to 120
7 -inch top, 30 feet	450 pounds each	From 55 to 95
8 -inch top, 30 feet	550 pounds each	From 45 to 80
6 -inch top, 35 feet	450 pounds each	From 70 to 90
7 -inch top, 35 feet	600 pounds each	From 50 to 70
8 -inch top, 35 feet	730 pounds each	From 40 to 60
6 -inch top, 40 feet	625 pounds each	From 50 to 65
7 -inch top, 40 feet	800 pounds each	From 40 to 55
8 -inch top, 40 feet	975 pounds each	From 30 to 45
DOUBLE CARS		
7 -inch top, 45 feet	1,000 pounds each	From 60 to 70
8 -inch top, 45 feet	1,150 pounds each	From 52 to 58
7 -inch top, 50 feet	1,250 pounds each	From 48 to 55
8 -inch top, 50 feet	1,350 pounds each	From 44 to 48
7 -inch top, 55 feet	1,550 pounds each	From 39 to 42
8 -inch top, 55 feet	1,750 pounds each	From 34 to 37
7 -inch top, 60 feet	2,000 pounds each	From 30 to 33
7 -inch top, 65 feet	2,700 pounds each	From 23 to 25

TABLE III
POLE LINE HARDWARE—WASHERS
2¼"x2¼"x$\frac{5}{16}$"—weight per 100, 25 pounds

ROUND WASHERS, IRON
$\frac{5}{16}$" for $\frac{5}{16}$" bolt, 65 to the pound
$\frac{7}{16}$" for $\frac{7}{16}$" bolt, 42 to the pound
$\frac{1}{2}$" for $\frac{1}{2}$" bolt, 22 to the pound
$\frac{5}{8}$" for $\frac{5}{8}$" bolt, 10 to the pound

GALVANIZED ANCHOR RODS WITH NUTS
$\frac{5}{8}$"x 6'—Weight per 100 rods, 720 pounds
$\frac{5}{8}$"x 7'—Weight per 100 rods, 820 pounds
$\frac{5}{8}$"x 8'—Weight per 100 rods, 940 pounds
$\frac{5}{8}$"x 9'—Weight per 100 rods, 1,050 pounds
$\frac{5}{8}$"x10'—Weight per 100 rods, 1,155 pounds
$\frac{3}{4}$"x 6'—Weight per 100 rods, 1,025 pounds
$\frac{3}{4}$"x 7'—Weight per 100 rods, 1,200 pounds
$\frac{3}{4}$"x 8'—Weight per 100 rods, 1,320 pounds
$\frac{3}{4}$"x 9'—Weight per 100 rods, 1,485 pounds
$\frac{3}{4}$"x10'—Weight per 100 rods, 1,640 pounds
1"x10'—Weight per 100 rods, 2,554 pounds

NAILS—LENGTH AND NUMBER TO THE POUND
4d—Length, 1½"; Number per pound, 296
6d—Length, 2 "; Number per pound, 168
8d—Length, 2½"; Number per pound, 88
10d—Length, 3 "; Number per pound, 60
12d—Length, 3¼"; Number per pound, 48
20d—Length, 4 "; Number per pound, 24
30d—Length, 4½"; Number per pound, 17
40d—Length, 5 "; Number per pound, 13
60d—Length, 6 "; Number per pound, 8

MACHINE BOLTS

Diam. Length	¼ lbs.	$\frac{5}{16}$ lbs.	⅜ lbs.	$\frac{7}{16}$ lbs.	½ lbs.	$\frac{9}{16}$ lbs.	⅝ lbs.
1½	3.9	6.2	9.7	14.7	20.4	28.0	37.0
2	4.6	7.2	11.3	16.5	22.4	29.0	39.9
2½	5.4	8.2	12.9	18.8	25.0	32.2	44.1
3	6.2	9.3	14.5	20.5	27.8	35.4	48.3
3½	6.9	10.4	16.1	22.6	30.6	38.7	52.5
4	7.6	11.5	17.7	24.7	33.4	42.0	56.7
4½	8.3	12.6	19.2	26.8	36.2	45.3	60.9
5	9.0	13.7	20.7	28.9	39.0	48.6	65.1
5½	9.7	14.8	22.2	31.0	41.8	51.9	69.2
6	10.4	15.9	23.7	33.1	44.6	55.2	73.4
6½	11.1	17.0	25.2	35.2	47.4	58.5	77.6
7	11.8	18.1	26.7	37.3	50.2	61.8	81.8
7½	12.7	19.2	28.2	39.4	53.1	65.1	86.0
8	13.2	20.3	29.7	41.5	56.5	68.5	90.0
9	...	...	33.1	45.7	61.5	75.2	98.0
10	...	...	36.5	49.9	67.0	81.9	106.3
11	...	...	40.0	54.1	72.5	88.7	114.6
12	...	...	43.5	58.3	78.0	95.5	122.9
13	...	...	47.0	62.5	83.5	102.3	131.2
14	...	...	50.5	66.7	89.0	109.1	139.5
15	...	...	54.0	70.9	94.5	116.0	148.0
16	...	...	57.5	75.1	100.0	123.0	156.5
17	...	...	61.0	79.3	105.5	130.0	165.0
18	...	...	64.5	83.5	111.0	137.0	173.5

BOLTS CABLE SUSPENSION, WITH NUTS ONLY
A—One Messenger. B—Two Messengers.

Sizes
A—⅝".....10", 12", 14", 16", 18", 20"
Sizes
B—⅝".....12", 14", 16", 18", 20"

TABLE IV
INSULATORS
2 Piece Transposition
125 per barrel; weight per 1,000 packed, 2,025 pounds or 235 pounds per barrel
No. 9 Pony
400 per barrel; weight per 1,000 packed, 785 pounds or 314 pounds per barrel
No. 11 and No. 12 Pony
400 per barrel; weight per 1,000 packed, 750 pounds or 318 pounds per barrel
16 Ounce A. T. & T.
300 per barrel; weight per 1,000 packed, 1,100 pounds of 330 pounds per barrel

TABLE VI
Size of Guy Wire for Various Strains
50 pr., No. 19 or 100 pr. No. 22 B. & S., 6,000 lbs.
50 to 100 pr., No. 19 or 120 to 200 No. 22 B. & S., 10,000 pounds
All larger cable, 16,500 pounds
The above is for spans less than 145 feet.

TABLE V
Diameter and Breaking Strain of Guy Wire

High Strength Diameter	Brk. Str.	Extra High Strength Diameter	Brk. Str.
½"	18,000	$\frac{5}{16}$"	24,750
$\frac{7}{16}$"	16,500	$\frac{3}{8}$"	22,500
$\frac{3}{8}$"	15,000	$\frac{7}{16}$"	17,250
$\frac{5}{16}$"	11,500	½"	12,100
¼"	8,100	$\frac{7}{16}$"	10,900
$\frac{3}{16}$"	5,100	¼"	7,600
$\frac{1}{8}$"	3,300	$\frac{3}{16}$"	4,900

John Coffey Friendly Receiver for Southern Michigan

Grand Rapids, Mich.—John W. Coffey of Indianapolis has been named receiver for the Southern Michigan Telephone Co. The company claims solvency, but seeks protection "against designing creditors." Headquarters will be moved to Sturgis, Mich. The company now is making money, it is stated. Replacement value of the property is approximately $2,000,000, with a depreciated value around $1,400,000.

Paris Commerce Body Urges Private Phone Control

Paris, France.—Paris Chamber of Commerce has resolved that French government, as measure of urgency, should transfer telephone service from state to private control and operation, saying private management would yield a profit and improve service.

Liberal, Mo.—Liberal Mutual Telephone Co. contemplates extensive improvements.

Owosso, Mich.—Union Telephone Co. has voted capital stock increase from $1,500,000 to $2,000,000.

Berlin, Germany—The Reichstag has under consideration a bill providing transfer of the state telephone system to private management.

S. M. Greer Returns to C. & P.

Baltimore, Md.—Samuel M. Greer, who was general commercial superintendent of the Chesapeake and Potomac Telephone Co. until August, 1917, when he went with the Red Cross in an executive capacity, has returned to the C. & P. as vice-president in charge of commercial activities.

The Plant and Good Service

A Discussion Based on Sound Engineering Principles of the More Important Features of Design, Construction and Maintenance of the Telephone Plant and Their Effect Upon Service*

By J. N. KIRK

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There is probably no industry in this country today which is developing more rapidly and which in connection with the tremendous volume of work being handled is rendering a higher quality of service to the public generally than the Telephone business. This problem of giving telephone service is considerably different from that of most business enterprises in that the manufacturer for instance, is generally in a position to exercise direct control over his activities and the output of his business, while in the telephone industry it is essential that such business as is offered be taken or else the company fails in its obligation to serve the public and in its realization of maximum efficiency. Further, the activities of the telephone business are of such nature as to make it essential, regardless of the remoteness of the territory or of the physical and climatic conditions involved, that a way be found to construct and maintain the plant and to safeguard the service to the public.

To meet these exacting requirements calls for the greatest ingenuity and foresight in the design of the plant and involves careful study with regard to the economic selection of plans covering plant extensions and rearrangements. Having determined the fundamentals of design, there must be devised ways and means of economically and safely constructing the plant and of efficiently maintaining it. The very nature of the telephone plant, scattered as it is over such a large territory emphasizes the necessity, in so far as is practicable, for the uniformity or standardization of practices affecting the design as well as the construction and maintenance activities and the materials associated therewith.

In the early days of the telephone business when the plant consisted of a simple combination of aerial wires and poles, there was no great need for prearranged plans and standards of design and construction, as both the engineering and the construction problems were comparatively simple. The rapidly growing complexity of the situation is, however, constantly introducing many difficult problems which can best be met and in fact can be satisfactorily met only if some broad plan giving full consideration to the future possibilities in their relation to the existing plant is developed and adhered to. This underlying thought applies in a relative measure to the small as well as to the large plant.

In the state of Indiana alone there are today in the neighborhood of 900 central offices and over one-half million telephones. The adoption of a carefully arranged program carried out in accordance with well chosen standards of design and construction is clearly essential if the plant extensions and rearrangements are to be made in an orderly manner and economically fitted into the existing plant structure.

Through the adoption of uniform methods and practices there is further presented the best possible means of educating the new men who are constantly coming into the business and also of developing the older men along systematized lines thereby promoting the highest degree of efficiency among the operating and engineering forces. It seems opportune as a matter of further educational value to emphasize at this point, the necessity for the closest possible cooperation between all departmental organizations. Those charged directly with the responsibility for the design of the plant and the methods to be employed in constructing and maintaining it, must also be familiar with the duties and general methods of operation of the Commercial, Traffic, Building and Equipment departments, etc., and must have a clear picture of the actual construction possibilities and limitations if the best all around results are to be accomplished. In other words, those responsible for any branch of the business should be familiar with those features of the other's activities which may have anything in common with, or bear upon the final conclusions of the problem under consideration. When this coordination of effort is complete, standardization has largely been accomplished.

Telephone Plant Design Has Been Based on Experience

A large portion of the telephone plant has been designed and constructed principally on the basis of past experience. This practice has undoubtedly been beneficial in the development of practical considerations, but full advantage has probably not been taken of the technical features concerned. Care must be exercised not to in any way belittle past experience but rather to realize that a combination of both technical and practical considerations must be applied, particularly in constructing the outside portion of the plant. The best results cannot be obtained by the application of either one without the other. Generally speaking, therefore, it would seem that too little engineering and an excess of rule of thumb methods are still being applied, at least in certain parts of the plant.

Engineering design, particularly as applied to the outside plant, must naturally be governed to a large extent by local conditions, matters of policy and many other features affecting each individual problem. While it is not generally practicable to specify exact methods for engineering this type of plant it is possible and very important, however, to acquaint the plant engineering forces with the broad fundamental principles upon which their work should be based, to establish a common basis of judgment and to instruct the engineers in uniform methods of formulating and solving their daily problems.

In connection with the design of pole lines for example, it seems desirable that they be classified in some orderly manner so that they may be constructed and maintained consistent with their general service values both from the standpoint of service to the public and of economic value to the company. Through the proper classification of the lines and careful consideration of the loads which they are to carry, and the intensity and frequency of storms to which they will be subjected, it is possible to select poles so as to guard against inconsistencies in the distribution and use of available pole timber. It is of course quite impracticable to devote the time and study in each particular case which is necessary for the economic selection of poles to meet

*A paper presented at a recent telephone conference at Purdue University.

these conditions. However, specification standards can be developed taking into consideration all of the features involved which will enable those responsible for the planning of the work to make a quick selection of poles with reasonable assurance that they will economically meet requirements. These features of design determine the size and spacing of poles, establish the basis for their maintenance and upkeep and to some extent govern the life of poles and the conservation of timber. Economic pole life and the conservation of pole timber, however, are now being more directly controlled by the application of preservatives such as creosote oil, both before installation and later in the service life of the pole.

Only One Best Way of Doing the Job

There are infrequently more than one or two equally satisfactory, efficient and economical methods of planning and constructing a given unit or type of plant and usually there is but one best way of doing any job. Without some definitely established procedure, innumerable methods are likely to be developed as the result of individual experience and judgment, and which incidentally may be more or less biased by local conditions. It will readily be appreciated, therefore, that to secure the best grade of work, both with regard to design and construction requires most careful study and planning. It seems apparent that the results of such study can best be presented to the operating forces in the form of carefully prepared practices. These standards of practice present a medium through which not only the operating forces but also the engineers may be encouraged in practicing economy and efficiency in their daily work, much of which would perhaps be of such small magnitude, if considered on the basis of day to day requirements, as to discourage detail study.

It would seem as if the state of the telephone art were now such that no great amount of inherent difference should exist in the way work is generally carried out by the different operating companies. In other words, it seems very desirable that telephone men the country over should speak the same language. In addition to promoting a clearer understanding of the day-to-day problems and minimizing useless or misdirected efforts, this uniformity of action greatly simplifies any transfer of forces from one locality to another which may be occasioned by emergencies or for other reasons. As an illustration, there seems to be no good reason why the actual splicing of cable wires and the completing of the splice should be handled in a certain way in one part of the country and in an entirely different manner in other parts. It is recognized, of course, that deviations from any established practice may occasionally be necessary in order to meet unusual physical, climatic or other special conditions which may obtain in a given territory.

The Small Exchange Problem

Considering now the small exchange problem, i. e., one of say less than 500 stations. In many cases such exchanges constitute an important factor in the profitable operation of a company as a whole. An inefficiently operated small exchange is almost certain to react seriously upon the company not only in the way of an unsatisfactory financial showing but also upon the morale of operating forces and in the general effect upon the public. Engineering and construction practices involved in connection with this type of plant require careful study both with regard to general plant layout and to selection of materials used.

Generally speaking, it would involve unnecessary expense and loss of time if the plant additions required in each small exchange were based on detailed studies of each individual case. In the great majority of such cases it is entirely practicable to make fairly broad application of standards which have been determined as the result of careful study and investigation of similar properties.

Following are a few of the more important features in connection with plant extensions and rearrangements in the small exchanges which may be of interest: First, some sort of general pole plan should be available as a guide for the engineer in handling the small plant extensions. This plan should indicate a method of reaching the potential subscribers with the thought of keeping the length of distribution and subscriber loops consistent with standard construction, practices and economical design. Second, the initial introduction of underground construction into a small exchange should not be considered unless absolutely required by local conditions because of the high first cost of this type of construction, and the idle or non-productive investment caused by providing duct space considerably in advance of requirements. In those cases where underground construction must, for some cause, be established, care should be taken to restrict its extension to necessity rather than to provide what may appear to be a better and more complete job. Third, the use of poles which can be obtained locally, assuming that they are of sufficient size and durability to insure proper strength and life, should be given careful consideration. Fourth, it must, of course, be recognized that an adequate and comprehensive cable plant in a small exchange materially reduces the maintenance expense as well as the cost of providing new connections. Before constructing the plant on this basis, however, it should be well established that the cable will make possible either a reduction in the maintenance man-power or that the expected growth is sufficient to warrant the idle investment in temporarily unused cable conductors. Fifth, before any work is undertaken "to reduce excessive maintenance cost" a careful analysis should be made to determine whether these excessive costs are real or only apparent. In such cases, the standard of measurement for determining the desirability of a particular plant which is proposed to reduce the maintenance expense in any locality should be the maintenance man-power required before and after completion of the work. In other words, reductions in maintenance expense should be considered only where they are actual and not theoretical reductions.

Advantages of Joint Pole Use

Another problem of rapidly growing importance to all telephone companies is that involving the joint use of poles with light and power companies. The construction standards in connection with this matter have now become well established. In the preparation of the National Electrical Safety Code thorough consideration was given to this very important matter and the present edition of the Safety Code sets forth the general principles and requirements for such construction. In general the joint use of poles has proved itself by long years of experience to possess advantages and economies of great benefit to the wire using utilities. These advantages are of such important character that every reasonable effort should be made to prevent any general movement toward unnecessary duplication of pole line construction. If the principles and practices which have been developed to cover the joint use of poles are adhered to, there is every reason to believe that safety, good service and economy will be insured and that the most efficient and economical use will be made of the poles required for distribution service in the plants of the power and telephone companies.

Standardization of Materials

Suppose we consider now a few features associated with the standardization of material used in the construction of the telephone plant. This matter is becoming an increasingly important one not only because of the first cost economies but because of the fact that the standardization of materials makes for greatly increased uniformity of operation. Quantity production of any material, assuming of course that quality essentials are fully met, will result in cheaper materials and conse-

quently in lower plant costs. Production on a large scale is, of course, greatly promoted if the number of kinds, sizes and types of material entering into the plant makeup can be kept at a minimum.

It has been said that standardization is today the most important approach to greater industrial efficiency. Failure to carry out the principles of standardization in a thorough-going way undoubtedly results in great industrial waste. As an illustration of the excessive multiplicity of sizes and styles of merchandise, information is available to the effect that three axe manufacturers are making common axes in 34 types, 4 grades, 35 brands, 11 finishes, 19 sizes; 6,118 varieties being actually listed. The waste through the creating and keeping of the necessary facilities for making so many varieties, through stoppages due to short runs and through the keeping of all this material in stock is enormous.

A great deal has already been accomplished in line with reducing material costs by the careful selection and standardization of materials used in telephone work. Many of the very minor materials used in large quantities such, for example, as bolts and screws offer great opportunity through careful selection as to kind, size, etc., for important economies. Also small commercial tools, such, for example, as pliers, screwdrivers, bits, etc., of which there are hundreds of kinds, sizes and types and in the aggregate a very large quantity used in the construction of the inside and outside plant, is another item of considerable importance. Careful study and co-ordination of the uses to which these tools are put will result in very material economies.

As an illustration of the potential possibilities along this line, investigations recently made have indicated that where some thirty-nine different types and sizes of pliers were in use, careful selection would reduce the number of types to five. It was further clearly apparent that this number would serve the purpose just as efficiently as the larger number formerly employed.

Introduction of Labor Saving Tools

Most careful consideration and study should also be given to the introduction of the larger tools and to construction apparatus and labor saving devices which permit greatly increased economy and uniformity of operation, such as winches for all sorts of heavy lifting and pulling, pole derricks for handling and erecting poles, boring machines for digging pole and anchor holes, cable and pole trailers, various compressed air tools and a number of similar devices.

Some idea may be gathered as to the great economies and time saving advantages to be gained by the introduction of these labor saving units when it is realized that there is now available a machine which may be mounted on either truck or tractor depending upon the nature of the work and the territory involved that will drill in a few minutes a pole hole requiring by the old manual method anywhere from a few hours to perhaps a day to dig. Also the truck equipped with pole derrick requiring for its operation but two men and a chauffeur, handles with ease the heaviest poles generally used, either as a matter of erection or removal on account of replacement or dismantling. There are many other labor saving devices assisting in their respective fields to materially reduce the labor required so that the net economic results tend greatly to counteract the prevailing tendency toward increasing construction and maintenance costs.

Corrective and Preventive Maintenance

Let us turn now from design and construction features to consideration of the broad subject of maintenance which may be divided into two main classes, corrective and preventive. The average unit of plant, regardless of how well it may have been designed and installed, is subject to wear, damage or may develop defects during its period of usefulness. These defects, such perhaps as loose bolts or connections, broken insulators, dirty connections, worn parts, poor insulation and a number of minor impairments may individually be of a rather unimportant nature. While they may not in themselves either seriously impair or to any appreciable extent affect the service life of the plant, they will nevertheless, if allowed to accumulate, result in a gradual lowering of the quality of the service, will lessen the resistance of the plant to damage through unusual causes and will in general tend to shorten the service life of the plant.

There is a growing tendency, therefore, toward the adoption of preventive maintenance measures which tendency should result in a very material saving rather than an increase in the cost of keeping the plant in serviceable condition. The amount of preventive maintenance work which should be performed can best be determined by finding the economic balance between the cost of such maintenance and the expense incident to the clearing of troubles. In so far as considerations of economy will permit, the leaning should, of course, be toward the performance of preventive maintenance work, since this favors better service. For example, in central office maintenance, the preventive maintenance work consists largely of routine testing and inspection of equipment. The value of a particular test and the frequency with which it should be made is a problem of balancing the cost of the routine work against the cost of clearing preventable troubles.

Wherever an analysis of the cost of preventive maintenance work is made it is interesting to note the large amount of preventive work which can be justified, particularly when reliable cost figures are available. This result seems reasonable when it is realized that trouble must be cleared when and where it occurs, whereas preventive work may be planned and executed in an orderly manner in conjunction with other work which may be on hand.

It is also of interest to note how much less maintenance work is actually required where preventive measures are employed. Some idea of the unlimited opportunities for important economies in connection with the operation and maintenance of electrically operated apparatus may be obtained from a series of field tests which were conducted some four years ago on relays in service. In this test a group of 500 relays were adjusted in accordance with standard requirements and the covers sealed. After a service period of over three years only a few of these relays changed in adjustment, and the changes which did take place were not sufficient to have caused any service reaction. In making adjustments of electrical apparatus of this nature, it is, of course, essential that such work be carried out with a fair degree of accuracy. For example, to accomplish the best results on most of the electrically operated apparatus the adjustments should be made on the basis of the current flow method.

Some indication of the improvement in maintenance results, which may be expected where adjustments of this nature are properly made, may be gathered from the following field experience. In a group of 100,000 line and cutoff relays, the number of troubles causing service impairments, where relay adjustments had been made on the basis of the current flow method, were approximately one-third of the number of troubles which occurred in the same period of time in a similar number of relays which were not adjusted by the current flow method. Likewise the amount of preventive maintenance work required in the first instance was much less than that in the second.

The necessity for preventive maintenance is important in a manual office but is very essential in the case of machine switching equipment where there is no human element to assist in the spotting of troubles. From both

a service and an economic standpoint, it therefore seems very necessary that every possible effort be made to anticipate any troubles which due to the complexity of the mechanism involved are so difficult to trace after the troubles have actually occurred.

Preventing Recurring Trouble

Prevention of the recurrence of trouble is a matter which is almost entirely within control of the men clearing the trouble and depends to a large extent on the manner in which the work is done. Because of this, it is very evident that each man assigned to any particular phase of the maintenance work should be fully advised regarding the most efficient methods to be used in connection with that work. It is of importance also that the men become thoroughly familiar with the operating functions of the apparatus which they are maintaining for the best results cannot be obtained in cases where the actual operation of a particular piece of apparatus is not clearly understood.

It is felt that in a large number of cases a decided improvement in service with an ultimate savings in maintenance costs can be effected if an extended effort is made to give the men performing the maintenance work such training and information as will enable them to clear trouble in a lasting manner. With regard to this training, it is felt that the school method co-ordinated with instruction work in the field should give the best results. Where local conditions are such, however, that it is impracticable to have the men spend the necessary time in a school, good results should be obtained through individual instruction on the job.

Damage to Cable Sheath as a Source of Trouble

Aside from extraordinary damage, such as may result from sleet storms, floods, fires, etc., the most serious types of troubles, in so far as the effect upon continuity of service is concerned, are perhaps those involving damage to the sheaths of lead covered cables. The seriousness of such troubles arises from the fact that a relatively large number of circuits are grouped within a single sheath, and if moisture enters through a cable sheath it may penetrate to such an extent as to affect and seriously impair the serviceability of a large number, or all, of the conductors contained therein.

To prevent the total failure of a cable it has been found advisable upon receipt of a report of the failure of an individual line in a plant containing cable to locate the trouble immediately and if damage to the cable sheath is involved to undertake repairs at once. After having determined by a voltmeter test that the trouble is in the cable, the next step is to definitely locate the trouble by means of Wheatstone bridge measurements and to run the trouble down and clear it. In single office areas it has been found convenient to equip the wire chief with a Wheatstone bridge so that delays may be avoided in making the necessary location tests. The Wheatstone bridge may be mounted on the test desk and permanently connected to an outlet on the main frame to which test cords may be run to the terminals of the pair under test.

In a multi-office area where two or more central offices are connected by cable the Central Locating Bureau has been found to be an efficient method of quickly locating cable troubles. Such a bureau consists of a test desk on which is mounted a Wheatstone bridge, the necessary test keys and terminals of circuits extending to the several central offices within the area of the bureau's operation. These circuits serve simply as leads from the Wheatstone bridge at the central bureaus to the main frames of the other central offices in the area. The operation of this bureau is substantially the same as that just described for the central office where the wire chief is equipped with a Wheatstone bridge except that after the repairman has opened the circuit at the cable terminal and the wire chief has made his voltmeter test he then refers the trouble to the Central Bureau where the location is made immediately utilizing the station repairman to change connections at the cable terminal in order that the loop tests may be completed. As the bureau is equipped with accurate records of the cable plant the results of loop tests are readily associated with the cable maps or diagrams to show the location of the troubles with respect to particular poles or manholes. Upon the completion of the location the trouble is referred to the cable splicing department which immediately undertakes repairs. In this way cable troubles are cleared with a minimum of expense and so quickly after their detection that a complete failure of a cable is very unusual. The desirability and overall features of economy in adhering to carefully prepared and well established methods in connection with preventing major failures in the cable plant and consequent out-of-service difficulties is again emphasized.

Quality of Service Depends on Transmission Maintenance

Just a few words now with regard to transmission maintenance as it affects the quality of service. The giving of good service both toll and exchange depends to a considerable extent upon the ability to make the most efficient use of the existing plant facilities. One of the very important elements in accomplishing this result is to insure that the proper grade of transmission is maintained, first in the toll plant itself and second in the local plant which serves as the terminals for toll connections.

Analyses of toll line testing results indicate that very frequent routine tests on toll circuits are not required provided careful tests are made at the time the circuits are put in service and provided careful attention is given to carrying out an adequate routine for promptly reporting troubles to the maintenance forces and in locating and clearing troubles as reported. When new circuits are installed or existing circuits rearranged, certain tests should be made to insure that the work has been done properly and that the requirements for which the circuits are designed are met. If circuits are properly installed and tested initially there is not a great deal that can go wrong with them which can not be picked up by the regular test board or by a follow-up of the poor transmission reports if this work is carried out carefully. A check occasionally (once a year or so), by transmission measurements is, however, very desirable.

The testing facilities provided at test boards allow certain tests to be readily made which will indicate any common troubles affecting transmission adversely. When these tests are made on a routine basis, the results give a valuable guide in initiating clean-up work where most needed. Leakage, loop resistance and resistance balance tests are the ones which will give the best indication of the direct current condition of the plant. It would seem desirable that all such routine tests be made on all circuits periodically and that the results obtained from these tests be carefully analyzed for the purpose of putting into effect any required remedial measures, such as tree trimming, elimination of bad joints, inspection of cable boxes, protectors, etc. In sections where tree growth is very rapid, more frequent tests for leakage during the growing season may be desirable than would ordinarily be the case, although if the results of the periodic tests are carefully analyzed, and used to the best advantage, it should not generally be necessary to make more frequent tests.

Following a procedure such as just outlined will give fairly good assurance that the ordinary types of circuits involved in service will be satisfactory from a transmission standpoint. How-

ever, certain kinds of troubles are not readily apparent from direct current testing methods and in the final analysis, transmission tests and certain other alternating current tests are necessary to assure the highest grade of service. Transmission tests require apparatus designed to measure the volume efficiency of circuits in terms of some standard. Excepting in the large toll offices it is not necessary to provide transmission testing apparatus for each office. Portable apparatus can be used which may be carried from office to office and tests made at such intervals as are considered desirable, based on the maintenance conditions obtaining at the various locations. In this way a small amount of transmission testing apparatus is sufficient to check up a large number of circuits both toll and exchange.

In general, transmission testing work has become a very essential function not only in supplementing direct current tests but also in giving assurance that all the features which go to provide good telephone transmission are being maintained in a standard manner. Experience has shown that the value received in improved service, satisfied subscribers and increased revenues, warrants the relatively small expense involved in systematic transmission maintenance work.

Routine Maintenance Inspection of Pole Lines

Just a few words now with regard to the feature of maintenance as it relates to the routine inspection of pole lines. Inspection reports and the inspector's recommendations as to action to be taken regarding condemned poles should be carefully reviewed. The circumferences reported furnish the engineer or others charged with the responsibility of planning the work with a check of the condemned poles and with a definite basis upon which to consider the deferment of portions of the work. In many cases there may be features, however, the accuracy of which cannot be judged in the office without supplementary field inspections which would seldom be warranted and for which the inspector's recommendations must, therefore, be accepted without question. For this reason, it would seem as if serious consideration should be given to selecting for inspectors, men experienced in pole line construction or maintenance work who have shown real ability in judging pole timber and in planning minor rearrangements and changes in pole lines to improve right of way conditions, eliminate or reduce difficult construction features or decrease expense. It is the function of the inspector to call attention to such condemned poles as might be reset or stub reinforced so that in reviewing the inspection reports the engineer can intelligently decide what action should be taken in each case.

It should be recognized that generally accepted standards of practice are not necessarily always applicable. To illustrate this point, the replacing of poles to create uniform and so-called standard spacing may be cited as a case which often results in considerable unnecessary expenditure. In the construction of any pole line it is, of course, desirable to make the spacing uniform and of reasonable length but it is usually neither practicable nor economical to apply this reasoning to any appreciable part of the existing plant. In the reconstruction or maintenance of a line, it is seldom economical to respace poles unless the existing spans are such as to have been the real cause of extraordinary wire damage. Here again a review of the inspection reports places a check on such practice and permits of specifying replacements with poles of a class consistent with the existing spacing. In view of the foregoing, it seems desirable that any construction or maintenance methods which may be devised should be flexible enough to meet practically any combination of local conditions both in existing and proposed plant.

Effect of Sleet Storms in the Wire Plant

It might be of interest as a matter of maintenance to add just a word with regard to the effect of sleet storms upon the pole and wire plant. Practically the entire state of Indiana lies in what has been designated by the Bureau of Standards as the heavy sleet loading area, in other words, an area in which the diameter of sleet and ice covering the wires periodically, accumulates to the extent of ¾-inch diameter or greater.

It is neither difficult nor expensive to construct the aerial plant so that it will withstand winds of relatively high velocity provided the wires are free of sleet. A deposit of sleet, however, rapidly increases the area against which the force of the wind is directed and the resulting load constitutes one of the most formidable and most difficult to anticipate of any of the destructive agencies with which wire using companies have to contend. Maintenance difficulties unfortunately are not necessarily at an end with a lessening of cessation of the wind for this change may often increase the precipitation of sleet which, undisturbed by the wind, builds up around the wires, frequently stressing them beyond the breaking point. Inasmuch as a large proportion of the poles are periodically exposed to storms by heavy loading intensity, it is essential that they be designed, constructed and maintained in such a manner as to insure minimum interruption of service consistent with the practicable and economical design of the plant as a whole. Here again, the preparation and use of carefully developed standards has been of essential value.

An attempt has been made in the foregoing discussion to briefly touch upon some of the more important considerations affecting the design, construction and upkeep of the telephone plant and to point out in a very general way the desirability of and the economic features involved in the adherence to a well defined plan which employs uniform methods and practices. The ground which has been covered is doubtless substantially that which is familiar to those associated with the telephone business who are interested in the particular phases of the work which have been touched upon. In a line of work, however, which is expanding and progressing as rapidly as that of the telephone industry, there must constantly be developing more efficient ways and means of doing things. Perhaps, therefore, some thoughts of interest may have been brought out which through further discussion and study will result in a clearer understanding and further simplification of the problems which confront all of us.

South Due for Big Year, Says Landon Smith

Irvington, N. J.—Landon P. Smith, president of Smith & Hemenway Co., Inc., manufacturers of "Red Devil" tools, Irvington, N. J., has just returned from an extended trip in the South, and expresses great optimism about the business conditions for this year.

Says Mr. Smith: "Handsome boulevards with large estates and beautiful residences are extended to what was formerly the rural districts. Furniture factories, iron and steel works, woodworking plants, textile mills of every description, leather manufactories and other big industrial enterprises have sprung up as if by magic.

"Here cotton buyers from Germany, France, England and Belgium are seeking to fill all their requirements. Cotton is in enormous demand, with resultant high prices. This has a tendency to increase the purchasing power of the South to a greater extent than has been possible in the last few years."

Long Distance Transmission

A Discussion of Transmission Theory and Practice as Applied in the Modern Long Distance Telephone Plant. First of Two Articles on This Important Subject

By Dr. K. W. Wagner and F. J. Dommerque

The greater part of the present long distance systems consist of open wire lines, but in future development, unquestionably, a change to cable will take place wherever traffic will warrant it. In the first place, cables are less affected by wind and weather and by the action of the magnetic field of paralleling power transmission lines than open wire lines. A second advantage is the possibility of crowding into a cable about 50 per cent more conversations during a given time than can be accommodated by open wire service. Third, from the economical standpoint, a conversion to cable is most advantageous because it permits the use of small gauge wire (No. 19 B. & S. G.), a size which for mechanical reasons is out of the question for open wire construction.

It is only a short time since the use of such small wire for long distance work has been made possible. It has become possible with the invention of the electron tube repeater, which made possible long distance telephone conversation, as for instance, between New York and San Francisco.

A further development in long distance telephony is the introduction of multiple service with carrier currents. This subject, however, will not be taken up here.

In this discussion, a sketch or outline of the principles upon which the modern long distance telephone systems are being developed will be presented to the reader. It is the intention not to go, to any depth, into theoretical explanations and calculations, so that a less scientifically inclined person will not lay the paper aside, believing it to be outside of his power of understanding. The subject, however, being of a physical nature, will be interspersed with a few mathematical expressions which will serve to elucidate it. No deduction of the expressions will be given and the reader, who is not as accustomed to a technical consideration or representation of physical phenomena as an engineer would be, may pass over the mathematical expressions without losing the instructive value of the discussion.

A Unit of Measurement Is Necessary

To determine the efficiency of any installation, the results achieved by the enterprise must be ascertained; that is, the products must be measured. In the telephone industry, the product is transmission of speech. To measure the transmission efficiency, a transmission unit must be established. As it happens, there are two transmission units in existence, or rather two expressions for one and the same thing. The one is a purely theoretical unit; the other a purely practical designation. The practical unit has found its greatest friends in America and England, while up to this time Continental Europe has adhered practically exclusively to the theoretical unit.

As the practical unit adopted in America a mile of standard cable has been chosen. This cable has the following electrical constants:

Conductors—No. 19 B. & S. gauge, paper and air insulated wires in twisted pairs, dry, within a leaden sheath. Wire diameter = 0.03589" (0.912 mm.).

Resistance—88 ohms per loop mile (54.68 ohms per loop kilometer).

Inductance—10^{-3} henry per loop mile (0.6213×10^{-3} henry per loop kilometer).

Leakance—5×10^{-6} mhos. per loop mile (3.107×10^{-6} mhos. per loop kilometer).

Capacity—0.54×10^{-7} farad per loop mile (0.3355×10^{-7} farad per loop kilometer).

The transmission efficiency of any telephone line, circuit or piece of apparatus is stated by giving its transmission equivalent. Thus, the practical transmission equivalent may be defined as follows: The transmission equivalent of any type of line (or apparatus) is the mileage of such type of line (or apparatus) which gives transmission equal to that given by one mile of standard cable.

The Theoretical Unit of Transmission

The transmission equivalent is obtained, theoretically, by dividing the attenuation constant of standard cable by the attenuation constant of the type of line (or apparatus) in question.

It will now be necessary to explain the attenuation constant. By doing this the theoretical transmission unit is defined at the same time.

The power delivered to a telephone line at the sending end, when talking, amounts to from 0.1 to 15 milliwatts, depending on the quality of speech and the construction of the sending instrument; 2 milliwatts may be taken as an average.

The power received by the instrument at the far end should be at least 0.002 milliwatts to enable the listener to understand the conversation distinctly.

The ratio of the power sent (N_s) and the power received (N_r) gives a measure for the attenuation of the speech in the line between talking and receiving instrument. This ratio is expressed by the simple equation

$$\frac{N_s}{N_r} = \epsilon^{2b} \qquad (1)$$

wherein ϵ is the base of the Napierian logarithms and "b" the attenuation measure or length. The attenuation measure or length of a line is the product of the line length into the attenuation constant α. The attenuation constant α is the real part of the propagation constant which is the vector attenuation of the line and gives both the decrease in magnitude of the current and also its face retardation. The propagation constant is mathematically expressed as $\alpha + j\beta$ and is equal to

$$\sqrt{(R + j\omega L)\,(G + j\omega C)} \qquad (2)$$

where R = Resistance, L = Inductance, G = Leakance, C = Capacity, all per loop, unit of circuit; $j = \sqrt{-1}$; $\omega = 2\pi f$; f = frequency. α = Attenuation Constant, is the horizontal or real step of the Propagation Constant and represents the decrease in the magnitude of the current. β = Wavelength Constant, is the vertical or imaginary step of the Propagation Constant. The Wavelength

$$\lambda = \frac{2\pi}{\beta}$$

If the average values of N_s and N_r are inserted in equation (1) the value of "b" is =

$$\tfrac{1}{2} \log_{\epsilon} \frac{N_s}{N_r} = 1.15 \log_{10} \frac{2}{0.002} = 3.5 \qquad (3)$$

in round figures.

In the value of 3.5 are included also

the losses in the switchboard and other office equipment as well as the reflection losses at the junction of line sections of different construction and impedance. The losses in the office and in the subscriber's connection plus the reflection losses can be taken as 0.6 on the average (1.0 as maximum) for each subscriber or as 2 for both subscriber's connections, leaving as a maximum permissible "b" the value 1.5.

Dealing with real values the attenuation of a line is represented by the product of length of line l into the attenuation constant α, whence

$$b = \alpha l. \quad (4)$$

This is the theoretical transmission unit. Considering that the value ωC is always much greater than the value of G and in most cases the inductive resistance ωL many times smaller than the ohmic resistance R, α can be expressed approximately as

$$\alpha = \frac{R}{2}\sqrt{\frac{C}{L}} + \frac{G}{2}\sqrt{\frac{L}{C}} \quad (5)$$

According to this formula α would be independent of the frequency. This is only approximately true and then only over a certain range of application. A better value of α, although still approximate, would be

$$\alpha = \left(\frac{R}{2}\sqrt{\frac{C}{L}} + \frac{G}{2}\sqrt{\frac{L}{C}}\right) \times \left(1 - \frac{a^2}{8\omega^2}\right) \quad (5a)$$

wherein the constant a has the value

$$a = \frac{R}{L} - \frac{G}{C} \quad (5b)$$

This "a" designates the "distortion of speech."

Equation (5a) proves that attenuation for the lower frequency is smaller, whence it follows that the line transmits lower frequencies better than high frequencies.

Good transmission of speech requires that the frequencies from 300 to 2600 periods per second be transmitted uniformly; but in practice the transmission of the higher frequencies is considerably poorer than that of the low ones. Speech can still be understood if the frequencies above 2600 periods per second are suppressed.

Conversion from Theoretical to Practical Units

We have discussed the principles of transmission from the standpoint of the theoretical transmission unit. The step from the theoretical unit to the practical unit is an easy one. To transform αl into standard units we remember that we only need to know that the attenuation α of one standard mile equals 0.109, then we can express any transmission equivalent given in standard miles in the theoretical transmission unit αl by multiplying by 0.109.

In this discussion, we are not interested in reciting the transmission equivalent of lines and apparatus, but we are interested to know the length of line still permissible for clear transmission of speech. This we have expressed by saying that "b" must not exceed 1.5 for good transmission; we therefore state that

$$l = \frac{1.5}{\alpha} \quad (6)$$

where α designates the attenuation constant for the mean frequency of speech, f = 800. This gives $\omega = 2\pi f = 5000$.

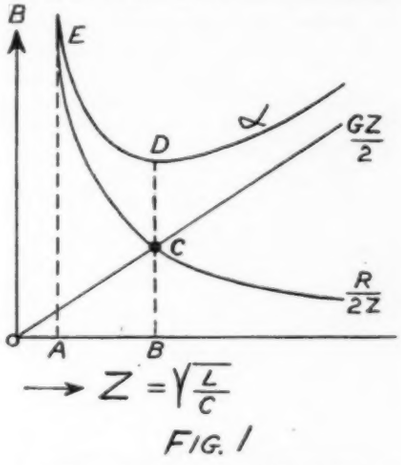


FIG. 1

Taking the standard cable as an example, we find $l = \frac{1.5}{0.109} = 14$ miles as the maximum permissible line attenuation for good transmission; however 18 miles would still be commercial transmission. If we take a No. 8 Birmingham Wire Gauge open wire, which has an attenuation constant of 0.0042, the maximum permissible line length would be $l = \frac{1.5}{0.0042} = 355$ miles.

With decreasing attenuation constant the permissible line length for good transmission increases. But there is a limit to the decrease, as long as it has to be brought about by an increase in copper. The amount of copper required increases as the square of the line mileage. Therefore, some other means must be found to decrease the attenuation constant for very long lines.

Use of Loading to Improve Transmission

Heaviside suggested, or rather demonstrated theoretically over 30 years ago, that an increase in line inductance would decrease the attenuation. In the expression for α given in equation (5), the first member $\frac{R}{2}\sqrt{\frac{C}{L}}$ is much greater than the second member, $\frac{G}{2}\sqrt{\frac{L}{C}}$, which holds good for all lines and cables of ordinary construction. In Fig. 1, the values of the two members are plotted with relation to the wave resistance $Z = \sqrt{\frac{L}{C}}$. The first member or resistance member can be written as $\frac{R}{2Z}$ and its values plotted give a curve which is an equilateral hyperbola. The second member written as $\frac{GZ}{2}$ can be plotted as a straight line. Adding respectively, ordinates of the two curves, the attenuation curve α is obtained, with a minimum at point D, Fig. 1.

An ordinary non-loaded line works about at point E of the α curve, which corresponds to a wave resistance OA. Consequently, increasing the wave resistance from OA to OB will decrease the attenuation constant AE to the minimum value $BD = \sqrt{GR}$.

The wave resistance $Z = \sqrt{\frac{L}{C}}$ increases with increasing inductance L. The best means to decrease the attenuation is to increase the inductance.

Pupin showed, in 1901, a practical way to do this by inserting inductance coils at certain regular intervals in the line. This practice is known as "loading" the line.

In America, three kinds or degrees of loading have been evolved for use on cable lines: heavy loading with about 0.2 henry per mile and with spacing between loading coils of about 1¼ miles; medium loading: 0.1 henry per mile and 1¾ mile coil spacing; light loading: 0.05 henry per mile and 2½ mile coil spacing. As a rule open wire lines are heavy loaded with a coil spacing of 8 miles, spacing the first coil 4 miles from the beginning of the line and the last one 4 miles from the end.

Limiting Frequencies of Loaded Line

A loaded line has a limiting frequency, which is

$$f_o = \frac{\omega_o}{2\pi} = \frac{1}{\pi s\sqrt{LC}} \quad (7)$$

where s = distance between coils, L and C = inductance and capacity, respectively, per unit length of line. The attenuation measure of a line becomes too high when the limiting frequency is exceeded.

Below the limiting frequency the attenuation constant of the loaded line can be found by inserting for the line

resistance without the coils designated by R, the value

$$R' = R\left(1 - \frac{2\omega^2}{3\omega_0^2}\right) \quad (8)$$

and dividing the value of α found from equation (5), by $\sqrt{1-\left(\frac{\omega}{\omega_0}\right)^2}$

Then the attenuation constant for the loaded line will be

$$\alpha = \frac{1}{\sqrt{1-\left(\frac{\omega}{\omega_0}\right)^2}}\left(\frac{R_s + R'}{2Z} + \frac{GZ}{2}\right) \quad (9)$$

Wave resistance or impedance will be

$$Z = \sqrt{\frac{L_s + L}{C}} \quad (10)$$

where R_s and L_s designate Resistance and Inductance, respectively, of the coils per unit of length.

As is usually the case, the value of α for a certain line is given. Then the wave resistance or impedance Z is found by equation (9), and the inductance L_s, which is to be added, by equation (10). Equation (7) shows that when the load L_s is distributed over a great number of coils, that is, if s is made small, a high limiting frequency is obtained and the speech transmitted is of a correspondingly good quality, but the line construction costs more. The American practice used for years a limiting frequency of $\frac{14000}{2\pi} = 2200$ periods per second, while some European countries went as high as $\frac{20000}{2\pi} =$ 3200 periods per second, and hardly ever went below 2600 periods per second. High limiting frequency become more important when repeaters are introduced, as will be seen later.

Adding Distributed Inductance

Instead of adding lumped inductance to the line in the form of loading coils, the inductance may be increased by winding a continuous band or layer of iron wire around the cable core. To give an open copper wire such an iron envelope would not do, as it would rust. Besides there are mechanical difficulties. Therefore, this loading by a continuous iron wire, which was originally introduced by C. E. Krarup, a Danish engineer, is restricted to cables, and particularly to submarine cables. In this country it has found an application in the three Key West-Havana cables laid in 1921, which is the largest cable of this kind laid so far.

The increase in inductance is proportional to the magnetic permeability of the iron envelope; as the talking or speech currents are weak, the initial permeability becomes of importance; it is desirable to make it high. Pure or nearly pure iron has an initial permeability $\mu_0 = 100$; by using iron-nickel alloys (30 to 80% nickel) the initial permeability can be increased into the thousands. The Key West - Havana cables have an inductance of 0.00375 henry per mile and an initial permeability $\mu_0 = 140$. The iron-nickel alloys will without doubt play a great rôle in the future development of long-distance communication.

Here Is a Practical Example

The following is an example of a loaded long-distance line. Assuming the distance of the tollboard to the switching station at the outskirts of a city to be six miles. The cables between tollboard and switching station to be of No. 16 B. & S. G. conductors, the capacity (mutual) to be 0.0714 m.f. per mile. From the switching station in one direction an open wire circuit of No. 8 B. W. G. may extend for 150 miles, and in another direction for 100 miles. The No. 8 wire has a capacity of 0.009 m.f. per mile.

Employing heavy loading for the open wire circuits, that is, 0.2 henry in each loading coil, and spacing the coils 8 miles apart, would give, in the case of the 150-mile circuit, 18 coils. To obtain symmetrical spacing there should be 152 miles to the circuit; then the first coil would be placed 4 miles from the switching station, the next one 12 miles and so on, leaving again 4 miles from the last coil to the end of the circuit. As the section is only 150 miles long, a deviation from the full 8-mile spacing would have to be made, which, however, is no disadvantage.

The 100-mile circuit with 12 coils would deviate still more from a symmetrical spacing, if the 8 miles between coils were exactly adhered to. In the first case the symmetrical spacing with 150 miles would require a distance between coils of practically 7.9 miles, and in the second case of practically 7.7 miles. For sake of simplicity 8-mile spacing is figured. In practice a small deviation from the 8-mile distance would not increase the reflection losses, as the values of the characteristic impedances of the two sections are substantially the same. In the case under consideration, where the inductance is large in comparison to the resistance, the characteristic impedance has nearly the value $\sqrt{\frac{L}{C}}$; hence the open wire sections would have a characteristic impedance

$$Z = \sqrt{\frac{\frac{0.2}{8}}{0.009 \times 10^{-6}}}$$

$$= 1000\sqrt{\frac{0.025}{0.009}} = 1666 \text{ ohms.}$$

The following reasoning will give an easy means to determine the characteristic impedance for the cable section. The No. 8 open wire circuits are equipped with coils at every 8-mile section; the capacity of the No. 8 wire is 0.009 m.f. per mile, whence the capacity corresponding to one coil $= 0.009 \times 8 = 0.072$ m.f.

The No. 16 cable has a capacity of 0.0714 m.f. per mile, and $6 \times 0.0714 = 0.4284$ m.f. for its 6-mile length. Thus the 0.4284 m.f. of the cable corresponds to $\frac{0.4284}{0.072} = 5.95$, or in round figures to 6-coil spaces. This would bring the spacing of the loading coils for the cable to 1 mile per coil; half a mile from the switching station to the first coil and the five others a mile apart from each other.

In the cable case the characteristic impedance would be

$$Z = \sqrt{\frac{\frac{0.2}{1}}{0.0714 \times 10^{-6}}}$$

$$= 10000\sqrt{\frac{0.2}{0.0714}} = 1676$$

ohms, which agrees well with the impedance of the No. 8 circuits.

From practical experience it appears that the characteristic impedance of loaded long-distance lines, cable as well as open wire, should remain preferably between the limits of 1400 and 1800 ohms.

(To be continued in our next issue)

Pierce County, Wis., Deal Trade Between Independent and Bell

Chicago, Ill.—Transfers recorded in the April issue of Telephone Engineer did not involve any surrender of Independent property. A prominent Independent telephone man says:

"The Pierce County Telephone Co. was a part of the property of the Tri-State Telephone & Telegraph Co. of St. Paul, which was transferred to the Bell at the time of the exchange of territory in Minnesota. Tri-State had an interest in a few properties in Wisconsin, which under the agreement were eventually to go to the Wisconsin Telephone Co. Therefore, the taking over of the Pierce County property by the Wisconsin Bell was not a new deal.

"The majority of the transfers of Independent properties to the Bell nowadays are of this nature."

"Class A" Executives Meet

Independent Chiefs Represented in Consultation at Chica

Chicago, Ill.—Organization of the Class A Independent telephone companies into a definite group, with plans for regular meetings and a well coordinated program for dealing with the problems confronting these companies and the industry in general, was effected at a conference of the executives, accountants and engineers of nineteen Class A members of the United States Independent Telephone Assn., held at the Edgewater Beach Hotel, Chicago, April 24-26.

All sessions were of executive nature and the attendance was limited to the representatives of the Class A companies, so that the utmost freedom might be obtained in discussing the operations of different companies and the general problems confronting them. On each morning there was held a general meeting of all those who attended the conference, and on each afternoon there were held separate group meetings of the executives, the accountants, and the engineers.

The questions discussed were the general problems of the industry, special attention being given to the need for closer co-operation among the Class A companies, the need for the adoption of more definite accounting standards especially with regard to depreciation, the need for the adoption of engineering standards and practice, and the need for more frequent meetings of these companies and the interchange of ideas and operating methods.

Plans were adopted for the organization of the executives into a definite group with several meetings to be held during each year. The accountants and engineers were also organized into permanent committees with definite programs and plans for regular meetings of these committees. A. C. Cragg, of the Tri-State Telephone & Telegraph Co., St. Paul, Minnesota, was elected Chairman of the Accountants' Committee, and A. L. Staderman, of the Citizens Independent Telephone Co., Terre Haute, Indiana, of the Engineers' Committee.

Each of these Committees is starting to work on a definite program for the adoption of standards and the improvement of methods in their respective fields. The plan of the National Association is that as soon as the newly created Committees of the Class A companies are functioning properly, meetings of the Class B and Class C companies will be held and later district meetings of all members including Class D companies, so that in time the entire Independent telephone industry will be organized along the same lines, with uniform standards of accounting and engineering practice.

At this conference charts were presented showing the detailed operations of each of the Class A Independent telephone companies for the years 1922 and 1923. Plans were adopted for the future interchange of similar statistics and data regarding operating methods by the executives of the different companies. Following the meeting the figures shown below were made public representing the combined operations for the years 1916, 1921, 1922 and 1923, of the thirty-three Class A members of the United States Independent Telephone Association.

Class "A" Independent Telephone Companies
(33 Member Companies)
Comparative Statistics

	1916	1921	1922	1923	Increase 1916-1923	Increase 1922-1923	
Number of Central Offices	630	699	698	692	62	6	(d)
Number of Telephones	480,278	695,691	727,049	786,963	306,685	59,914	
Fixed Capital	83,538,680	119,491,594	134,997,356	138,272,701	54,734,021	3,275,345	
Total Assets	94,031,254	138,694,607	152,201,801	158,377,210	64,345,956	6,175,409	
Capital Stock	40,713,164	49,681,868	53,972,844	57,529,002	16,815,838	3,556,158	
Funded Debt	33,933,297	55,759,028	54,588,370	53,853,850	19,920,553	734,520	(d)
Operating Revenue	13,245,658	27,267,267	30,592,371	32,749,550	19,503,892	2,157,179	
Depreciation	1,651,636	4,291,520	4,498,036	5,120,845	3,469,209	622,809	
Current Maintenance	2,150,477	4,741,013	4,844,918	5,039,617	2,889,140	194,699	
Traffic	2,295,678	6,961,314	7,313,123	7,174,476	4,878,798	138,647	(d)
Commercial & General	2,038,467	4,432,560	4,685,724	4,838,863	2,800,396	153,139	
Total Operating Expenses	8,136,258	20,426,407	21,341,801	22,173,801	14,037,543	832,000	
Net Operating Revenue	5,109,400	6,840,860	9,250,570	10,575,749	5,466,349	1,325,179	
Taxes	561,912	1,923,125	1,798,499	2,085,299	1,523,387	286,800	
Other Deductions	333,125	891,393	847,599	934,262	601,137	86,663	
Total Deductions	895,037	2,814,518	2,646,098	3,019,561	2,124,524	373,463	
Income available for Interest and Dividends	4,214,363	4,026,342	6,604,472	7,556,188	3,341,825	951,716	
Interest	1,666,664	2,904,647	3,049,855	3,413,969	1,747,305	364,114	
Net Income (Available for Dividends)	2,547,699	1,121,695	3,554,617	4,142,219	1,594,520	587,602	
Percentages							
Income available for Interest & Div. to Fixed Capital	5.1%	3.4%	4.9%	5.4%			
Net Income to Capital Stock	6.2%	2.3%	6.6%	7.2%			
Interest to Funded Debt	4.9%	5.2%	5.6%	6.3%			
Operating Ratio	61.5%	74.9%	69.7%	67.7%			

Milo Gurney Advertising Chief, Federal T. & T. Co.

New York, N. Y.—Following his successful career as district manager of the Chicago office of the Federal T. & T. Co., manufacturers of Federal telephone and radio equipment, Milo Gurney has been advanced by that company to the position of advertising manager.

Mr. Gurney has been associated with the Federal T. & T. Co. for a number of years and brings to his new appointment a very practical sales experience and viewpoint. He will have offices with the Federal company, New York City.

London, Eng.—Telephone service between London and Berlin soon will be possible over the London-Emden cable.

Astoria, Ill.—Earl Yocom, formerly of Willsville, Ill., has bought the local telephone exchange.

Eagle River, Wis.—A company is being organized to build a telephone system connecting State Line and Eagle River. Connections between Arbor Vitae or Woodruff and the Big St. Germaine lake country also are planned.

Marion, N. C.—Capital stock of the Marion Telephone Co. has been increased from $10,000 to $100,000.

Restoring Japanese Service

Japanese telephone authorities hope to complete installation of telephones in 30,000 houses by next summer. The total expenditure for restoration of telephone and telegraph service is estimated at 230,000,000 yen.

Armathwaite, Tenn.—The Peoples Mutual Telephone Co. has been incorporated with $5,000 capital by Chas. C. Brooks, J. C. Tompkins, J. A. Norman, W. S. Pierce and Max Taubert.

C. W. Horn of Indianapolis now is local manager for the Citizens Telephone Co., at Havana, Ill., succeeding Thomas Colwell, deceased.

Fuller Again Empire Chief

Up-State New York Association Holds Convention

Rochester, N. Y.—Headed by George R. Fuller as president and J. G. Ihmsen as vice-president and general manager, the Up-State Telephone Association's officers were re-elected at the annual meeting held here. Directors were elected as follows: G. R. Fuller, J. G. Ihmsen, G. G. W. Green, John H. Wright, H. P. McDonough, F. C. Saunders, W. A. Seeley, F. D. Fancher, H. W. Fluher, J. P. Boylan, B. H. Brooks and L. H. Jenks.

One of the most practical and interesting programs of state convention history was presented. Covering the financial phases were addresses on application of the budget system by F. J. Brookman, V. P., Rochester Telo. Corp., taxation of telephone property by Geo. Rymers, and on simplified accounting for small companies, by Seaborn N. Vines of Syracuse.

Practical plant problems were featured in the talks made by John P. Boylan, V. P. and Genl. Mgr. of the Rochester Telo. Corp., on increased efficiency of manual exchange equipment, on inductive co-ordination by Frank F. Fowle of Chicago and an address and demonstration of plant maintenance, presented by R. M. Bruce, plant superintendent of Rochester. George R. Folds of Chicago also was one of the headliners in this part of the program with a paper on protecting central office and substation equipment from static and high tension currents.

F. B. MacKinnon, president of the U. S. I. T. A., was a featured speaker. The radical group in congress was the subject of the remarks made by John B. Maling.

Nineteen short papers, covering every angle of the operators' work, were read before the operators' conference over which Miss Lillian A. Vavasour presided.

Leading makers of Independent telephone apparatus and supplies and other companies serving the telephone industry co-operated in staging an excellent exhibition.

Luncheons and theater parties given by Stromberg-Carlson and Kellogg companies were high-lights of the entertainment program.

Two Kellogg Men Who Have Made Good Records

A new man with the Kellogg Switchboard & Supply Co. is F. B. Knefel, who now handles the northern Ohio territory, and already has made many friends for Kellogg and himself. Mr. Knefel, who is a Chicagoan by birth, was educated in the Chicago schools. He started in 1903 as night operator for the Carroll County Telephone Co., Delphi, Ind. In 1904 he was employed as stock clerk at Kellogg's Chicago plant; then with the Western Electric Co. and the Chicago Bell Telephone Co. From there Mr. Knefel went to St. Louis for the Missouri Bell and thence with the Pacific States Telephone & Telegraph Co. at San Francisco. Thus he covered practically every department of telephone work, and even several specialty lines, having been with the Union Iron Works at San Francisco a year and a half in charge of marine telephones and signal equipment. Also, he was plant chief for nine years with the Sydney (Ohio) Telephone Co.

J. R. Spivey, who has been with the Kellogg Switchboard & Supply Co. since April 15, 1923, now is assisting Glanton Smith in Virginia and West Virginia. Mr. Spivey has worked with the Portsmouth, Norfolk and Lynchburg telephone companies, and has been associated with the Allen properties at Corinth, the Bluefield Telephone Co. and the Ashland Telephone Co. He is a competent telephone man and an expert on circuits of all kinds. Mr. Spivey began his telephone career as night operator with the Yazoo Valley Telephone Co. and later was office man for the Virginia and Tennessee Telephone Co. During the war, Mr. Spivey was wire chief of the Port of Embarkation, embracing Camps Stewart, Hill, Alexander, Port Office Exchange and the Base Hospital.

F. B. Knefel

J. R. Spivey

Hillsboro, N. D.—A new building is to be erected by the Traill County Telephone Co. here.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

of Telephone Engineer, published monthly at Chicago, Ill., for April 1, 1924.

State of Illinois, County of Cook, ss.

Before me, a notary public, in and for the state and county aforesaid, personally appeared W. H. Graffis, who, having been duly sworn according to law, deposes and says that he is the general manager of Telephone Engineer and that the following is to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, general manager and business manager are:

Publisher, Telephone Engineer, Chicago, Ill.

Editor, Herbert Graffis, Chicago, Ill.

General Manager, W. H. Graffis, Chicago, Ill.

Business Manager, Jos. M. Graffis, Chicago, Ill.

2. That the owners are (give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders, owning or holding one percent or more of the total amount of stock):

W. H. Graffis, Herbert Graffis and Jos. M. Graffis, all of 28 E. Jackson Blvd., Chicago, Ill.

3. That the known bondholders, mortgagees and other security holders owning or holding one percent or more of total amount of bonds, mortgages, or other securities are (if there are none, so state):

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustees or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any person, association or corporation has any interest, direct or indirect, in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed through the mails or otherwise, to paid subscribers during the six months preceding the date above is..... (This information is required from daily publications only.)

TELEPHONE ENGINEER,
W. H. Graffis, Gen. Mgr.

Sworn to and subscribed before me this 22nd day of March, 1924.

(Seal) C. A. LE ROY.

(My commission expires Oct. 4, 1926.)

In the Dead of Night

In the dead of night a fire breaks out—the alarm must be given. A child is taken sick—the doctor must be called. A thief enters the home—the police must be located.

In the dead of night the American turns to his telephone, confident he will find it ready for the emergency. He knows that telephone exchanges are open always, the operators at their switchboards, the wires ready to vibrate with his words. He has only to lift the receiver from its hook to hear that calm, prompt "Number, please." The constant availability of his telephone gives him security, and makes his life more effective in wider horizons.

Twenty-four-hour service, which is the standard set by the Bell System, is the exception in the service of Continental Europe. An emergency may occur at any time. Continuous and reliable service has become a part of the social and economic fibre of American life.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES
BELL SYSTEM
One Policy, One System, Universal Service

WHY DON'T YOU?

Large number of operating Telephone Companies use this Cross Arm Arrester

Stops Loss of Cable Pairs

Use two or three ahead of Cable Terminal. It pays

202

NO. 202—SELF-CLEANING SAWTOOTH LIGHTNING ARRESTER STOPS OPEN WIRE LEADS FROM CARRYING DISRUPTIVE CURRENTS INTO CABLES

Reliable Electric Company

3145 CARROLL AVENUE, CHICAGO, ILL., U. S. A.

Iowa Meet Plans Financing

Problems Are Discussed at Annual Meeting

IOWA RE-ELECTS

Pres., F. M. Boardman, Nevada.

Vice-Pres., E. L. Farwell, Manchester.

Sec.-Treas., Charles C. Deering, Des Moines.

Executive Committee: The president, the vice-president, O. L. Loudenslager, Le Mars; F. G. Moore, Washington; J. M. Plaister, Fort Dodge, and H. L. Beyer, Grinnell.

Des Moines, Ia.—The Iowa Independent Telephone Association is the latest one of the state groups to plan a financing body for the service of its members. The work was started at the well-attended annual meeting of the association. Financing occupied a prominent place in the meeting's program, for in addition to the attention given the association financing plan, there were addresses on taxation, insurance and national association activities, in which the almighty dollar theme registered strongest.

Two practical plant addresses were among the convention features. H. B. Melick, West Liberty, in speaking on "Plant Problems," emphasized the importance of a systematic and thorough investigation of plant and equipment. Mr. Melick told of the economies effected by the practice in his plant, and mentioned the value of an Ever-Protect covering for buried cable, and protection at the cable terminal as noteworthy factors. Neatness of inside and outside plant, he also stated, was an important item in the well-conducted operation.

F. G. Moore, Washington, spoke on "Underground Cable Construction," telling what he did when it became necessary to do extensive rebuilding and construction of the Washington distribution system. He spoke of getting soil analyses from the Iowa State College from samples taken from the proposed location of buried cable. He related an experience with buried cable beneath a gutter where considerable refuse drained, and there was a nearby ground from lightning arresters connected to a high voltage transmission line. His cable was eventually laid in sand because of the absence of soil impurities, and the good drainage. Adequate grounds were installed at frequent intervals as further protection.

How Iowa Helped Members

Secretary Deering of the association detailed the help the association had been to its membership in inductive interference, franchise, legislative, and plant matters.

President George W. Robinson of the Tri-State T. and T. Co., in speaking on the work of the national association outlined the efforts taken by the U.S.I.T.A. to solve the financing, operating, and public relations problems of telephone companies. Rates, according to Mr. Robinson, continued to become a matter of greater seriousness.

In 1916, taxes of a certain telephone company were 4.62% of its expenses, in 1922 they were 7.60%. Chas. E. Hall, tax commissioner of the Northwestern Bell cited this example to impress upon telephone companies the menace he outlined in his address, "The Curb for Mounting Taxes." Proper legislative pressure and a knowledge of constitutional rights, Mr. Hall put forth as dampers on a taxation orgy.

Members of a Northwestern Bell first aid team, headed by J. J. Coughlan of Des Moines presented an interesting first aid demonstration. Others who figured prominently in the convention program were the Minnesota notables, J. C. Crowley, secretary of the Minne-

sota association, D. M. Neill, Red Wing, and J. W. Howatt, supervisor of telephones of the Minnesota commission. The convention was treated to an address, "Business, the Distinctive Glory of America," by Prof. J. P. Ryan of Grinnell, Ia.

With Miss Anne Barnes in charge, a chief operators' conference was held under the auspices of the engineering extension department of the Iowa State College.

California Meets

Bear State Independents Hold Lively Sessions of Annual Convention at Los Angeles

CALIFORNIA ELECTS

Pres.—C. A. Rolfe, Redlands.*

Vice Pres.—C. H. Lorbeer, Pomona.*

Treas.—P. R. Ferguson, Riverside.*

Sec.—Ernest Irwin.*

Executive Committee—F. H. Wright,* Covina; A. Wardman,* Whittier; T. A. Gould,* Redondo Beach; A. Terkel,* Reedley; C. F. Mason, Santa Monica; F. H. Crosby, San Francisco.

*** Re-elected.**

Los Angeles, Cal.—California reported progress of the planning being done for the financial help of the state's smaller Independent companies, at the annual meeting of the California Independent Telephone Assn. held here. No definite plan, however, has been formulated.

"Too many of those elected to the California legislature," said President Rolfe, "do not understand the differences existing between public utilities and ordinary forms of mercantile or manufacturing enterprises and a committee might well be appointed which might function as a committee on telephone information."

Mr. Rolfe spoke of the proposed California water and power bond legislation, saying, "While this only concerns power companies, its success would undoubtedly mean eventually district telephone systems governmentally owned, and would bring ruin to the small exchange business. Any act of co-operation we can take with the power companies in spreading reliable information with regard to public utilities, their investments, costs and returns will be effort well spent."

The Secretary's report laid stress on what he called "bootleg advertising"—that is, special classified lists, and numerical lists, directory covers and advertisements to fit over mouthpieces, etc. All these are detrimental to the service since the information thus furnished is not kept up to date, and also such advertising impairs the telephone companies' legitimate revenue from this source. Telephone companies are all trying to run their own business and let every other business alone. Some method should be used to warn others to "keep off the grass," Mr. Irwin remarked.

High tribute was paid by the convention to the California commission.

Missouri Is Shown

Annual Meeting Featured by Demonstrations and Big Attendance

MISSOURI RE-ELECTS

Pres.—Houck McHenry, Jefferson City, Capital Telephone Co.

1st V.-P.—A. M. Benedict, Richards, Richards Telephone Co.

2nd V.-P.—S. D. Thompson, Cameron, Cameron Telephone Co.

Third V.-P.—W. O. Randall, Joplin, Joplin Home Telephone Co.

4th V.-P.—A. T. Nelson, Lebanon, LaClede County Telephone Co.

Treas.—H. L. Harris, Kansas City, Kansas City Telephone Co.

Asst. Treas.—M. J. Hancock, Kansas City, Kansas City Telephone Co.

Membership Sec.—G. W. Schweer, Clinton, Missouri Union Telephone Co.

Sec.—Robert W. Hedrick, Jefferson City.

The Executive Committee.—S. T. Neil, Clinton, Mo.; R. A. Guthrie, Macon, Mo.; H. C. Todd, Maryville, Mo.; S. D. Thompson, Cameron, Mo.; C. A. Vedder, St. Louis, Mo.; M. L. Golloday, Holden, Mo.; H. L. Harris, Kansas City, Mo.; C. W. Boutin, Cape Girardeau, Mo.; W. H. Bassett, St. Louis, Mo.

Kansas City, Mo.—Some demonstrations that laid open the heart of plant maintenance, transmission, operating and radio problems held the close attention of the 300 telephone men and women who attended the annual meeting of the Missouri Telephone Association here.

B. D. Hull, general transmission and protection engineer of the Southwestern Bell, assisted by members of the Southwestern staff, presented an address and exhibits on the subject of "Plant Maintenance and Transmission Improvements." This was agreed to be one of the best of recent state convention features. This part of the program plainly brought out transmission losses due to various troubles and mistakes, by means of a phonograph, transmitter, amplifier and loud speaker. The penalties of poorly maintained lines, bad cords, weak batteries, poor joints, and other defects in equipment and construction were sharply revealed.

Again the demonstration came to the front when Harry Faris of the Kellogg Switchboard & Supply Co. spoke extemporaneously on "Radio and the Telephone Man." Mr. Faris, with the aid of a blackboard, solved some of the radio perplexities of his hearers, and furthered the cause which he is so ably and actively campaigning, profit from radio to the telephone industry.

Employees of the Kansas City Telephone Company presented a demonstration of correct operating methods.

That some Missouri telephone companies by evading tax payment have thrown a heavier burden of taxation on those companies that do stand the gaff, was the statement made by Roy H. Monier, chairman of the Missouri State Tax Commission. He said that the Missouri tax rate was among the lowest of any of the states in the Union, and in support of his claim compared the telephone taxation figures of 1913 and 1923. In 1923, Mr. Monier stated, taxes levied on Missouri telephone companies for state revenue were $1,553 less than in 1913, although valuation had increased from $11,000,000 to $30,000,000 in the ten-year period. The 1923 assessment was made on 100 more companies than the state ever had taxed in any previous year. In 1923, 334 companies reported for taxation. Up to the present, 336 companies have reported for 1924 taxes.

Thrift's Biography

E. L. Chase, manager of the securities department of Theodore Gary & Co., told "What Becomes of the Pay Envelope," and related the financial diary of a thrifty young man, which in its intimate detail and its demonstration of the opportunities for thrifty, gave the managers plenty of material for their campaigns for stock ownership by their employees, as well as for education further afield.

The remarks of Miss Pearl Thompson, traveling chief operator of the Illinois association on "Development of a Telephone Association Service Department Along Practical Lines," proved to be so convincing to the Missouri men that they later voted to employ a traveling chief operator.

A committee was appointed to handle toll compensation matters with the Southwestern Bell. At the suggestion of Charles C. Deering of the national association the convention went on record before Missouri's legislators at Washington, in favor of a repeal of the telephone message tax.

Savings to be effected by standardizing practice and the necessary printing forms, and telephone directories as well, were presented before the convention by R. M. Woolfolk of the Con P. Curran Printing Company, which has figured aggressively in promoting this economy.

The leading makers of Independent telephone equipment and supplies were represented at the convention.

BRAND YOUR POLES

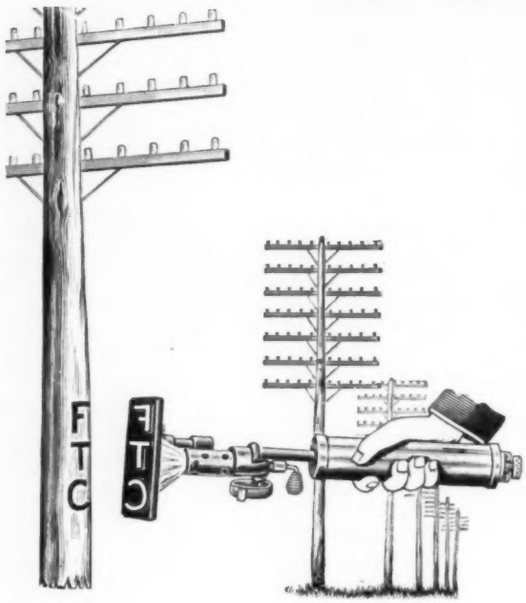
BRAND your new poles and crossarms while they are in the yards. This protects you against confusion as to ownership when they are delivered, ready to raise; at the same time, it marks your poles for future identification.

Brand your standing poles with company name and identification number, which make it easy to issue working orders telling linemen where to work.

Brand all your working tools and equipment to prevent intentional theft or unintentional appropriation.

The need you have felt for many years for an inexpensive, efficient and simple branding iron that would do the above branding work quickly, is answered in Everhot branding equipment. It is especially adapted for use in branding the kinds of equipment mentioned in this ad, and illustrated in the border.

You will be surprised to find out the low cost of Everhot branding equipment, and also surprised at the low cost of branding, due to the rapidity with which the Everhot works.



EVERHOT
America's Brand Makers
EVERHOT MFG. CO., Maywood, Illinois

George Presson Named Field Secretary by Nebraska

Lincoln, Neb.—George Presson, formerly the Lincoln T. & T. Co. manager at Stromsburg, Neb., has been named field secretary of the Nebraska Telephone Association.

Mr. Presson is admirably qualified to focus the resources of the state association in giving operating and financing advice and substantial assistance to the smaller companies in the state. Through the intimate contact of Mr. Presson in his new work, with the smaller companies, it is expected that these interests not only will become actively interested in the state association's work as members, but will be materially benefited in their financing and operations.

He begins his new work by a tour during which he will visit the various Nebraska telephone companies, soliciting their association membership and proffering the association's definite aid in the solution of local problems.

Norfolk, Va.—Expansion of Virginia's telephone system in 1924 will cost $2,370,000.

Philadelphia, Pa.—Bell Telephone Co. of Pa. plans to spend $175,000,000 on construction during the next five years.

Successful Quarter Century for Union Telephone Co.

Owosso, Mich.—On March 21, 1924, the Union Telephone Co. completed twenty-five years of corporate existence. During this quarter of a century the company grew from an idea to a successful corporation charged with public service in many communities, having a total population of nearly two hundred thousand people. There were 15,636 subscribers' telephones in service at the end of 1923, or a net gain of 376 for the year.

F. D. Lindquist, Ex-President of Minnesota Association, Dies

Fulda, Minn.—Frank D. Lindquist, secretary of the Fulda Telephone Co., and for several terms president of the Minnesota State Telephone Association, died at Rochester, Minn., April 12, after a prolonged illness. Mr. Lindquist was one of the prominent capitalists of southwestern Minnesota.

Wanted—bound or loose copies of TELEPHONE ENGINEER for the last six months of 1919 and for the entire year of 1920. Address, with price asked: H. G., care of TELEPHONE ENGINEER, 28 E. Jackson Blvd., Chicago.

NOT A DAY LOST IN 27 YEARS

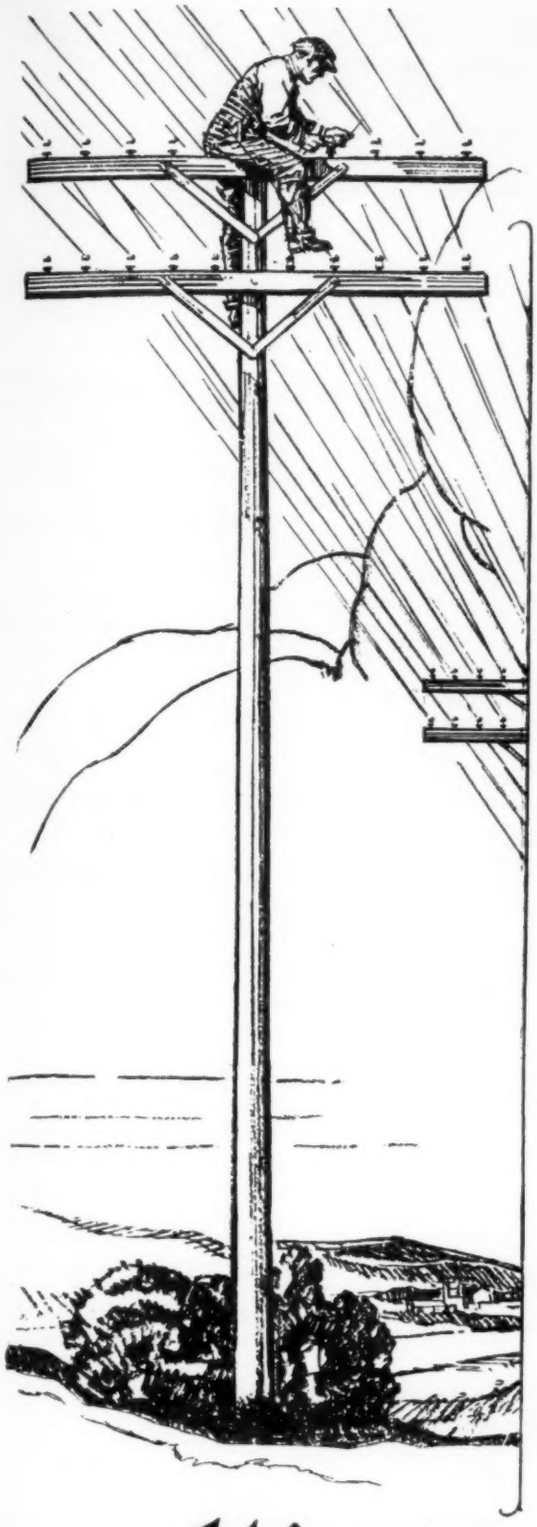
The public hears a great amount of talk today about modern machines, but little is heard of the improvements in machinery and methods used in telephone constructions.

I remember, about 20 years ago, we pulled cable with a hand windlass. It took four men to turn the "coffee grinder," as the men called it, and twelve men to pass the hooks after the rope was in. It took two and one-half to three hours to "grind" 1,000 feet of 50-pair cable through. Today, when the rope is through and ready to start, it takes ten to fifteen minutes to pull the same amount, with only six men to do the work.

In 1900 we did not think anything of working four or five days to set up a cable pole, but now it takes less than one-half a day to do the same work and it is not half as hard on the men.

I set the first 70-foot circle-top pole in Detroit, in February, 1898, west of Griswold, south of Fort, and removed the last one in June, 1922, south of Monroe.

I am starting on my twenty-seventh year of service in the Bell System. I have not lost a day in that time, from accident or sickness.—Louis Casenheiser, Line Foreman, Detroit, in "The Mouthpiece."



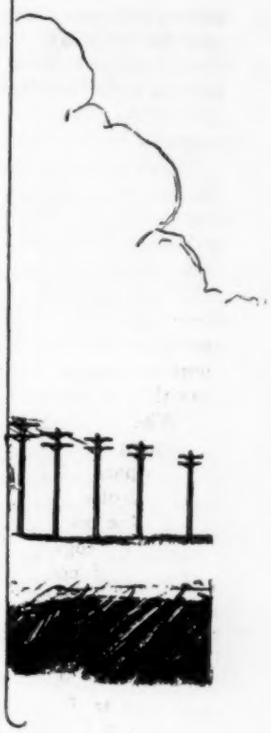
It tops them all!

On telephone lines all over the country, insulators provided by the Western Electric Co. are giving reliable service year in and year out.

At the top of the pole, these insulators are top notch in quality too—like all the supplies that Western Electric distributes.

This means everything from an anchor to a pole, everything in tools from pliers to earth boring and pole setting equipment. Western Electric stocks are complete, made up of countless items from nationally known manufacturers.

To expedite service our Houses are located at 47 strategic centers. One is near you to take care of your regular or emergency demands. For further particulars address it, or 100 East 42nd Street, New York City.



Western Electric Company

Offices in 47 Principal Cities

LINE AND DESK

OUR READERS GET SOME HELP

In the last issue of TELEPHONE ENGINEER, we were compelled to broadcast a call for help in the question of operation of shunt generator and mercury arc rectifier in parallel for battery charging. Evidently our call reached, not only listening ears but also willing helpers. One of those who replied was Mr. D. W. Phillips of the Ocala Telephone Co., Ocala, Fla. Mr. Phillips' letter follows

"I notice a query on page 33 of the April issue relative to the operation of mercury arc rectifiers in parallel with a shunt generator. I have operated them very satisfactorily in this manner.

"The method used is to start the generator (Delco 30 amp.) and then throw the rectifier in with it. Of course attention should be paid to getting the polarities right. In my case the generator was the regular charging unit and the rectifier the emergency unit so the polarities had already been correctly determined.

"Before putting the second unit on the line, the voltage should be as near that of the unit already running as possible to avoid a jerk or jar on the machine already in operation.

"In this particular instance, the maximum efficiency would be obtained by operating the generator at about 90 amperes and let the mercury arc take the other 35 amperes."

Another correspondent whose name is withheld but who has had experience both in the power and telephone fields has the following to say

"Whether or not a shunt generator and mercury arc rectifier can be operated in parallel depends on two things: the kind of a man who is trying to do it, and the power system. If the two are thrown together to charge the battery, and if conditions on the power system are steady, they can be operated. If the voltage or frequency of the power system varies, the division of load between the two will change and trouble may result. With the conditions given it would not seem to be necessary to run the two in parallel as the 100 ampere generator could be used to charge the battery by running longer. If the battery is a 1000 ampere-hour battery, it will charge as well on 100 amperes for 10 hours as on 125 amperes for 8 hours. If 125 amperes are needed for the initial charge, the generator can be overloaded. Most of the older generators have some overload capacity and, if it does overheat, a couple of electric fans blowing on it during the initial charge will keep it cool enough."

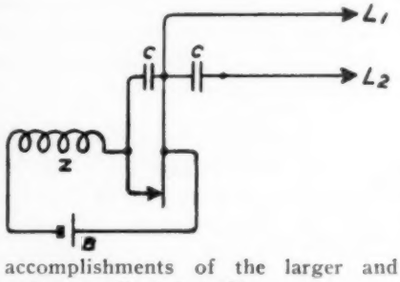
In addition to the above, we might add that power systems frequently are subjected to rather abrupt and severe changes of voltage and frequency. We knew of one system a few years ago, on which the frequency varied from 53 to about 70 cycles per second. This would make the operation of the parallel arrangement very difficult if not entirely impossible.

With the assistance of our generous readers, no doubt our querist will now be able to solve his difficulties.

A HANDY TONE SET

There are many excellent pieces of commercial apparatus on the market today for testing under every conceivable condition.

However, there are times when a small, compact, portable set known as a "tone set" can fulfill many of the



accomplishments of the larger and more complicated outfits.

Here is a sketch of a tone set that is light and takes very little room in the tool bag. Yet it is able to assist the trouble-man in finding shorts, grounds and crosses in office apparatus. For use as a tone in locating lost wires it is worth the cost alone.

One of the desirable features is that it can be assembled of standard parts. In the sketch C, C are two small condensers, say ¼ micro-farad or less. Z is a standard radio buzzer. The Federal is a dandy for this use. B is the battery, a Columbia Oval No. 4 dry cell. This with a little wire is all that is needed, and, after using this small affair, the writer is certain that its qualities will appeal to the operating man.—Contributed by Edwin F. Keyes.

LOOK OUT FOR LIVE WIRES

The Safety Bureau again finds it necessary to warn all our people that the average insulation on wires is an illusion and a snare when it comes to protecting one's life from electric light and power wires.

Recently, one of our men took a chance on the insulation covering one of our drop wires which he was pulling over a 13,000-volt line. The result was instant death when the drop came in contact with the high tension.

And here is another case: While off duty the attention of one of our employees was called by a police officer to an electric light wire lying on a sidewalk at an alley crossing. After making what he considered a careful examination of the insulation, and coming to the conclusion it would be safe to handle, the employee attempted to remove it from the sidewalk, with the idea of protecting the public in general from injury. He was knocked to the ground and suffered severe burns of the hand.

Under certain conditions, low voltage power and light circuits are also very dangerous, and the same precautions should be used when working around these wires as around those of high voltage.

We would also advise that you be careful when working on our own wires, as there is a possibility of them becoming crossed with power lines at some distant point. In fact, treat all wires as live and dangerous until you know they are otherwise.—"Bell Telephone News."

WHO HAS USED IRON SLEEVES?

One of our valued subscribers in the far west sends us an inquiry relative to the use of sleeve joints in iron line wire. Information on this subject is rather meagre. Although there are many companies using sleeves in iron wire, it seems that whatever experience they have accumulated has not yet found its way into print. We would like to help out our subscriber and we believe that the desired information

free—

This booklet will show you how to save money in laying your underground conduit. Send for it today.

—for permanence— this pressure creosoted Conduit

IN THE streets of Philadelphia there is today wooden creosoted conduit which has been in service for over 42 years. Dug up in 1907, when the sub-way was being built, 25 years after it was laid, this conduit was pronounced as good as new by the engineer in charge and was replaced.

Creo-pine pressure creosoted conduit is made of selected Southern yellow pine, free from any defects that would impair its usefulness. $4\frac{1}{2}$" square with a 3" bore through center; mortise at one end and tenon at the other.

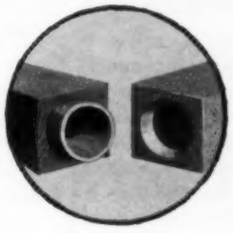
Creo-pine conduit is easy to handle and can be laid with rapidity by unskilled workmen. It requires only a narrow ditch.

Creo-pine conduit is used by the largest telephone and telegraph companies in America and is generally regarded as the standard of comparison.

Our facilities for supplying pressure creosoted telephone poles and cross arms are unexcelled. Quotations gladly furnished.

A few of the Big-Quantity Users of Creo-pine Conduit

American Telephone & Telegraph Co.
New England Telephone Co.
New York Telephone Co.
Southern Bell Telephone Co.
Cumberland Telephone Co.
Western Union Telegraph Co.
Postal Telegraph-Cable Co.
Mackay Telegraph-Cable Co.
N. Y., N. H. & H. Ry. Co.
Brooklyn Edison Co.
U. S. Army Signal Corps.
Engineering Departments of many cities and city alarm systems.



Creo-pine

Trade Name Reg.

CONDUIT

TELEPHONE POLES AND CROSS ARMS

Southern Wood Preserving Co.

Atlanta, Georgia

New York, Philadelphia, Pittsburgh, Buffalo, Cleveland, Toledo, Charlotte

Creosoting and Creo-pine Products

SEND FOR FREE BOOKLET

Southern Wood Preserving Co.,
Atlanta, Georgia

Gentlemen:—Kindly send me without obligation your booklet describing Creo-pine Conduit, together with information about your pressure creosoted poles and cross arms.

Name .....

Title .....

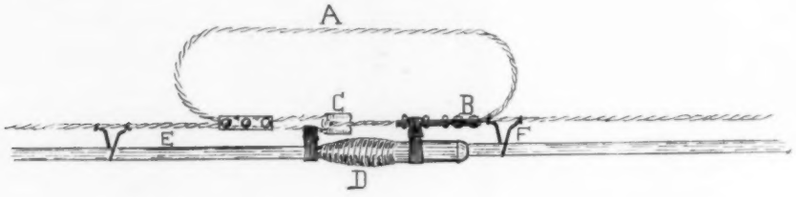
Address .....

will be forthcoming from some of our readers. The response we received to the query on the use of mercury arc rectifiers in parallel with a charging generator was prompt and helpful. Who now will be our helpers in this matter of iron wire sleeves?

WE ARE NOT SURE ABOUT THIS ONE

F. B. Wood, of Ottawa, Ontario, Canada, contributes the following suggestion. He asks for opinions from our readers. Send in your comments.

"Enclosed you will find a sketch giving details of a device which, if placed in aerial cables of any length, would facilitate the tracing of trouble caused by wet and dampness. In reading your very interesting magazine I thought this might be of interest to others.



It can be seen at a glance that, if placed in aerial cables at different intervals, opening the strand wire marked "A" at point marked "B" would cut the direct ground away from the suspension strand and cable in the section between the insulated splices. The cable tester at the office would by this means be able to tell the cable splicer, or troubleman, in which section between the splices the trouble lay. By placing this it would avoid opening wiped joints. Could this not be used to advantage in numerous cases? I would be pleased if you would let me know your opinion of this."

TO KEEP THE EXTENSION BELL FROM RINGING

I am sure readers of your paper appreciate reading about the stunts and hook-ups that appear in it from month to month. I don't think it would be fair to be using a good hook-up without letting others in on it. I have been using a little stunt of my own which may appear old to some yet new to others. Some subscribers in magneto exchanges are annoyed with extension bells ringing both ways, especially around mills, where the phone is in the foreman's office and extension bell in boiler room, or in similar places. Oftentimes someone calling from central draws the fireman from his work on a tomfool errand because the extension bell rings. This may be overcome by placing one side of the extension bell line to the nut on the generator, the other side to the ringer on the phone. Care should be taken to see that the wire on the bells is on the right side; otherwise we have a short. I might say that this stunt can only be used on a phone that shunts out its own bells, such as the Kellogg 2815 or 2659 and 2809 type. I trust this will be of some advantage to those who try it out.—Contributed by L. J. Melanson.

CALIFORNIA COMMISSION SPECIFIES DROP WIRE

In a recent letter to member companies, Secretary Ernest Irwin of the California Independent Telephone Association gives the substance of the ruling of the California Railroad Commission in the matter of types of drop wires permitted. Mr. Irwin says: "After almost a year's study of the matter, at the request of the association, the Railroad Commission has reached the conclusion that its General Order No. 64, Rule 93(a) refers to all wires not supported in space by a messenger, and that such wires include the services from the pole to the subscribers' houses. Subscribers' twisted pair drops shall therefore be, in size, not less than No. 14 A. W. G. (B&S) gauge copper twisted pair, or No. 17 A. W. G. copper-covered steel twisted pair, or its equivalent. We had asked the Commission to allow the use of No. 16 B&S copper drop wire, as several of our members were using this wire, particularly in the beach towns. The Commission is not able to see its way clear to allow this to be done.

CONVENTION SCHEDULE

WISCONSIN

Hotel Loraine, Madison; June 5, 6 and 7.

INDIANA

Claypool Hotel, Indianapolis; September 17 and 18.

Telephone Pioneers (Bell), Chicago, October 9, 10, 11.

U. S. INDEPENDENT

Hotel Sherman, Chicago; October 21, 22, 23 and 24.

ILLINOIS

Jefferson Hotel, Peoria; November 12 and 13.

Red Devil Tools Better Made

"Red Devil" Linemen's Tool Belts

Combine Safety with Utility

"RED DEVIL" Tool Belts afford a high safety factor and minimize the risks and hazards to linemen engaged in telephone, telegraph and general power line construction.

Linemen's Tool Belt No. 458

Specifications

Made of selected heavy black oak tanned leather. It has extra heavy D's and buckle and six loops—three 2 inch, two 3 inch and one 4 inch.

An extra length of leather is laid in across the back of this belt. The two ends of this piece are turned back smoothly through the D's for a distance of four inches and fastened securely by copper rivets and linen stitching. This puts two thicknesses of leather between the D's and against the strain. All loops are copper riveted and neatly scored.

PRICES AND WIDTHS
Each
2 "—$3.00; 2¼"—$3.25
2½"— 3.75; 3 "— 5.50

At dealers everywhere—or if not in stock, send dealers name and order from us.

Send for the "Red Devil" Electrician's Tool Booklet

SMITH & HEMENWAY CO., Inc.
Mfrs. of "Red Devil" Tools
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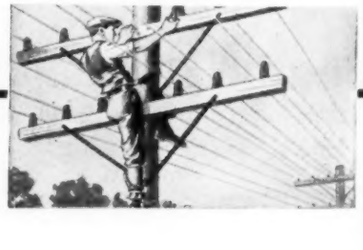
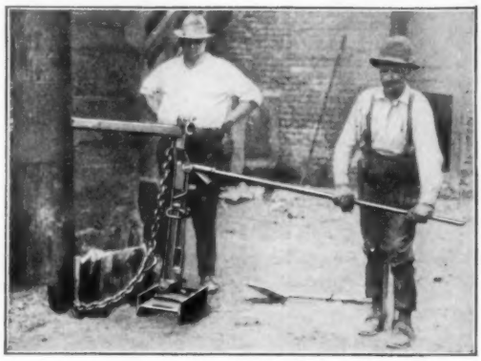
261 Broadway, New York, N. Y.

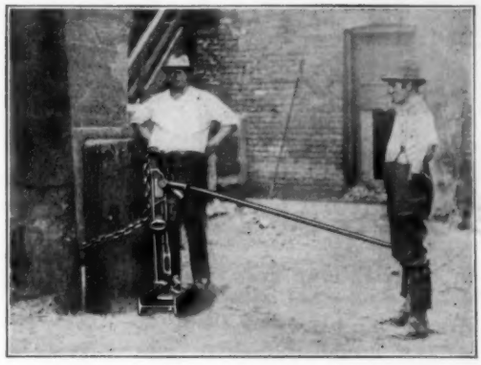


"Jack 'em out" SIMPLEX "Jack 'em out"

Pulling Pole Stumps Doesn't "Stump" Simplex Jacks

Does it Stump *Yours?*





JACKS JACKS

Simplex Pole Pulling and Pole Straightening Jacks will Pull a Pole Stump Quickly and Cleanly

No stump can resist the enormous manpower in a Simplex.

For such jobs this Jack saves man power and consequently it saves you time and money.

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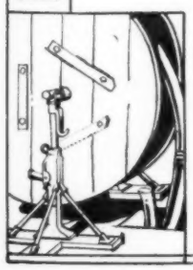
Western Electric Company

Offices in 47 Cities



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A successful phone silencer

TRADE MARK
HUSH-A-PHONE
REG. U. S. PAT. OFF.

Hundreds of telephone companies have endorsed the Hush-A-Phone, and over one hundred have made money selling it to their subscribers.

The Hush-A-Phone snaps instantly on the mouthpiece of any phone. It is not a permanent attachment. It accomplishes the same purpose as a telephone booth when a booth is not practicable.

Business men in all lines, bankers and professional men have need for a phone silencer and have warmly endorsed the Hush-A-Phone. Over two thousand banking institutions alone are now using it.

Voice Privacy
Facilitating confidential phone conversation.

Office Quiet
Prevents phone talk clamor—promotes order-taking accuracy—office efficiency.

Quiet Wire
Keeps surrounding noises out of the transmitter improving hearing.

Telephone companies write for our booklet T-1, and attractive resale proposition

Hush-A-Phone Corporation
Room 1333, 19 Madison Av., N. Y.

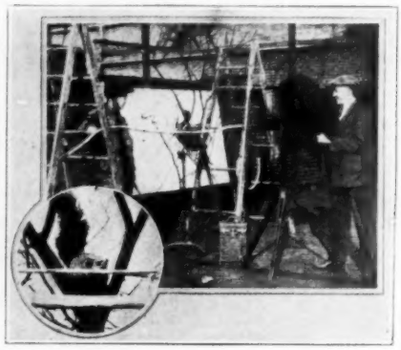
HE IS CAUGHT IN THE ACT

The accompanying picture is reproduced through courtesy of "Bell Telephone News." Photographers of the Illinois Bell Telephone Co. waited patiently for ten days before they secured this photographic evidence

against the culprit. It is stated that Mr. Squirrel desisted very promptly from his labors when his teeth finally hit the wires inside the cable, as one pair happened to have ringing current on it.

—And Here's Why They Waited Ten Days!

Sure enough the Illinois Bell men had to wait ten days before they were able to get the photograph of the squirrel dining on a "run" of cable.



The wait was caused by the taxidermist's non-delivery of a stuffed squirrel. The photograph herewith shows how the original picture was made by Jim Cleary, Illinois Bell photographer, and Fred Norwood of the company.

McKAY ARTICLES TO BE CONTINUED IN JUNE

Due to Mr. Charles W. McKay being engaged in a large valuation task, the May installments of the McKay serials, Practical Plant Problems and Valuation in Rate Making, are omitted.

The series will be continued in the June issue of TELEPHONE ENGINEER.

Right Up-To-Date

A Brand New Telephone Book by a Popular Author

TELEPHONY
INCLUDING
AUTOMATIC SWITCHING

By ARTHUR BESSEY SMITH, E. E.

THIS complete and authoritative work covers the principles and practice of modern telephonic communication with both manual and automatic switching. Construction of every switch, relay and contactor in the whole range of automatic devices is explained in detail, with testing and adjustment.

FULLY ILLUSTRATED

Photographs of apparatus and 157 wiring diagrams, show both the schematic circuits and connections used in all types of exchanges and instruments.

CONTENTS

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Automatic Switching: Hundred Line Exchange—Connector Switch, Line Switch, Finder Switch—The Automatic Instrument—Series Circuits—Booster Circuits with Polar and Non-polar Receivers — Thousand Line Exchange — Selector Switch, Trunk Slip. Ten Thousand Line Exchange — Secondary Lineswitches — Reverting Calls — The Multi-office Exchange, Manual and Automatic Types — Sub-offices — Large City Systems. Automatic Directors — Private Automatic Exchange (P. A. X.)—Special Functions Possible.

Power Plants—Battery Charging—Testing and Adjustment of Automatic apparatus—Telephone, Relays and Switch Mechanism—Toll and Automatic Toll—Effects of Resistance, Leakage, Inductance and Capacity—Private Branch Exchange (P. B. X.)—Measured Service and Pay Stations.

Pocket Size, Leatherette, 500 Pages, 263 Illustrations and Diagrams, Price $2.50

TELEPHONE ENGINEER
28 E. Jackson Blvd., CHICAGO

Portsmouth (Ohio) Company Soon in New Building

Portsmouth, O.—The Portsmouth Telephone Company is erecting a new two-story building just east of their present location. When completed it will house the general offices, including the cashier's, the bookkeeping department and the manager's office. An attractive rest and recreation room for the operators will be located on the second floor, which will be connected with the old building by a bridge so that the switchboard may be extended into the second building when the need arises. The new addition plant is of concrete, brick and stone and will cost more than $40,000. The company expects to occupy the new quarters by the first of May. It also has erected a new garage to house the ten or more automobiles used in the company's business.

"Copperweld" Name Gets Fame That Alters Company Title

Ranklin, Pa.—The name of the company making Aristos "Copperweld" wire has been changed from Copper Clad Steel Co. to Copperweld Steel Co. In announcing the change of corporate title, Robt. J. Frank, assistant manager of sales for the company, says:

"The increasing popularity and success of Copperweld wire (made by the Molten Welding Process) has been such in the past few years that the name of our wire—Copperweld—completely subordinated the name of our company, and the question has been asked us so many times, 'Why do you call yourselves the Copper Clad Steel Co. when you make Copperweld Wire?' that we could see no other way than to concede to the request of our customers and other friends, and change the name of our company from Copper Clad Steel Co. to Copperweld Steel Co."

Department of Commerce Radio Circular Revised

Washington, D. C.—A second edition of Bureau of Standards Circular No. 74 on Radio Instruments and Measurements has been issued. This circular presents information regarding the more important instruments and measurements actually used in radio work and is planned to be of use to government officers, radio engineers, etc. It makes no attempt to deal with the operation of apparatus in sending and receiving, but other publications by the Bureau on that and on other subjects are listed in Appendix 2.

San Diego, Cal.—During the next twelve months the Pacific T. and T. Co. will spend approximately $500,000 in service extension.

Morrison Host to Illinois District Meeting

Morrison, Ill.—April district convention of the Illinois Telephone Assn. brought representatives of many northwestern Illinois telephone companies here for interesting, practical sessions. Addresses were made by J. A. Riordan, president of the Morrison Telephone Co., Kirk Thompson of Erie, officers of the association, and by Robert F. Hallenberg, director of public relations of the Illinois Northern Utilities Co. W. C. Drysdale of Leich and Paul Meyers of Stromberg-Carlson spoke on development of radio equipment.

Illinois Consolidated Telephone Co., Taylorville, Ill., has been incorporated with a capital of $1,000,000 to deal in telephone exchanges, toll lines, supplies. Incorporators: E. A. Lumpkin, O. M. Burgess, C. W. Thompson. Correspondent: R. A. Lumpkin, 101 Wabash ave., Mattoon.

Lorin W. Timmons has purchased the Ware telephone lines at Omaha, Ark., and is rebuilding the system, which covers that section of Boone county and has long distance connections.

J. G. WRAY & CO.
Telephone Engineers
Specialists in Appraisals, Rate Surveys, Financial Investigations, Organization and Operation of Telephone Companies.
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Valuations—Supervision—Plant—Inductive Interference—Expert Administrative Counsel for Utilities
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TELEPHONE ENGINEER
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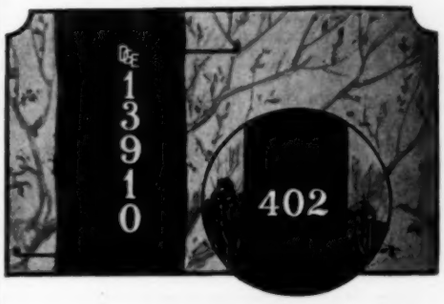
Stromberg-Carlson Co. Enjoys a Good Year

A very satisfactory financial showing for the year 1923 is disclosed in the annual report of the directors to the stockholders of the Stromberg-Carlson Telephone Manufacturing Co. Net income for the year amounted to $448,666.23. After deducting $64,025.06 for interest and federal taxes and $150,335.00 for dividends, the balance was carried to surplus making the total surplus at the end of the year $1,023,706.37. During the year the company acquired a factory site two blocks east of its present location and it is planning on erecting a building thereon during the present year to serve as a cabinet shop.

Celebrate G. R. Fuller's 25th Anniversary at Rochester

Rochester, N. Y.—George R. Fuller's 74th birthday, which also was the 25th anniversary of his election to the presidency of the Rochester Telephone Corp. and its predecessor, was celebrated by 350 employees of the company at a surprise party given Mr. Fuller. Mr. and Mrs. Fuller had recently returned from a trip to Egypt and Persia, their son George, Jr., being American consul at Bushire, Persia.



He tells of four distinct advantages

Recently an official of a large Public Service Corporation made these observations when discussing our PREMAX Aluminum Letters for pole marking, which outlasts the pole itself:

"We find it difficult to get proper labor for the job of stencilling the new poles, because the work does not warrant the wages of a high-priced man and efficient boys or cheaper labor are hard to obtain. We believe by adopting your PREMAX Metal Numbers and having our linemen number the poles when they are set, we can show a material saving in cost and be sure of legible and durable marking."

Quotations, sample numbers, all helpful information for the asking.

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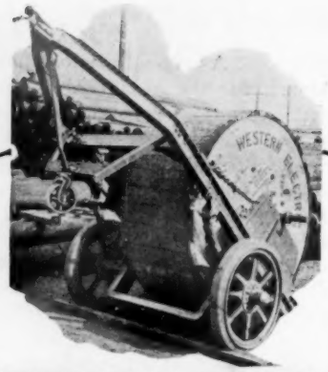

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CABLE REEL CARRIER and POLE DOLLY

TELEPHONE companies all over the country have found that the UTILITY is one of the most helpful items of construction equipment.

The UTILITY is made sturdy, well balanced, and convenient in every detail. It embodies every practical feature for a cable reel carrier and pole dolly.

Complete details of the UTILITY will be sent on request.

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at prices within your reach

When the best protection costs no more, why not have it? BRACH arresters insure; non-grounding of lines, cables, clear transmission, balance of potential between pairs, and full protection against power crosses or lightning. There are no carbons to clean and no maintenance bills.

You can readily afford BRACH Vacuum Arresters at our present low prices. Type 440, shown above, is furnished with porcelain base, fuses and mountings.

L. S. BRACH MFG. CO.
NEWARK, N. J.

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BUTT-TREATING - GUARANTEED GRADES
ANY SPECIFICATIONS REQUIRED
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"REBUILT" TELEPHONE APPARATUS and exchange equipment saves you 30 to 50 per cent without sacrificing quality or efficiency.

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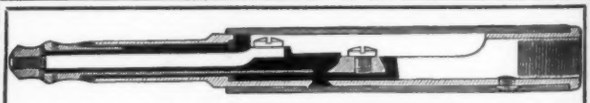
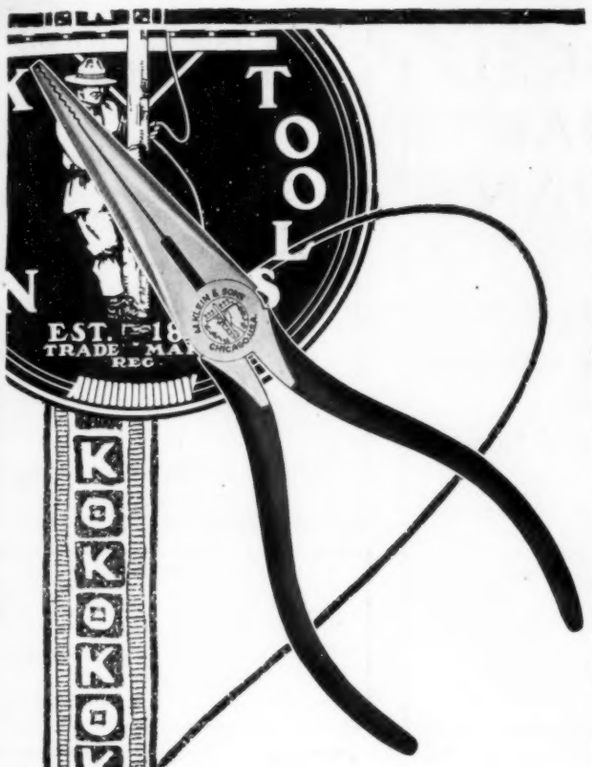


Specially insulated plugs. U. S. Patent 1302471. In use in five continents. Prices c. i. f. any place.

TELEFON FABRIK AUTOMATIC
7. AMALIEGADE COPENHAGEN DENMARK

Electrical Year Book for 1924 Is Off the Press

The third annual edition of the "EMF Electrical Year Book" has been issued by the Electrical Trade Publishing Co., Chicago. The book has been completely revised and enlarged to a total of 1,550 pages, of which 1,080 form the main text. It is a useful general reference work on all electrical activities and products. Included are some 600 encyclopedic topics and definitions of over 5,900 electrical words and terms. Much space is devoted to complete lists of manufacturers and nearly 3,200 classifications of equipment. Over 300 illustrations have been included in the text, which is arranged alphabetically.



What other pliers can stand the game? What other pliers have the right spring and curve to the handles — just the right temper to the knives —just the fine materials and manufacture that you expect and get in a Klein plier!

Buy them for *your* linemen.

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The standard anchor of companies whose engineering practice is standard for the industry.

Telephone companies of every size are using EVERSTICK Anchors because they are the best value in the world for holding hard and fast and for ease of installation.

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Every State in U. S. represented among our satisfied customers.

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Outside Plant and Underground Construction
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References, and List of Exchanges we have built, will be furnished on request.

PEERLESS Automatic Water Stills
Absolutely pure water for less than one or two cents a gallon, no matter how polluted your supply of water may be. For drinking, chemical or battery purposes the Peerless stills give you the best, ample supply at lowest cost. Operated without attention other than occasional cleaning.
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UNIVERSAL DROP WIRE INSULATORS
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CHEAPER than typewriter—SAVES 20% of YOUR present costs—5 to 15 times FASTER and BETTER than pen or typewriter.
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POSITION WANTED
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Address "E. D.," c/o TELEPHONE ENGINEER, 28 E. Jackson, Chicago

Our Literary Digest

Review of Recent Articles on Telephony and Allied Subjects

Telephony Including Automatic Switching, by Arthur Bessey Smith, Frederick J. Drake & Co., Chicago.

For a number of years there has been a distinct need for an introductory work on Telephony. The present book in a large measure supplies that need as far as it relates to telephone systems and equipment. It is in no sense a second edition of a previous work by the same author and published by the same publisher, which appeared some dozen years ago and which, at the time, had a wide sale among telephone men. The present text is a brief but thoroughly up-to-date presentation of the principles and operation of the more common systems now in operation in the telephone plants of this country. All historical matter which does not refer to these systems is omitted. It is written in a clear, understandable way that will be appreciated by the man in the field who does not have time or the inclination to study the more extended treatises. It will also serve as a first book for those who wish to continue their studies in some of the works that treat circuit principles and elements in a more complete way.

The first two hundred pages are devoted to manual practice, starting with the principles of the receiver and transmitter and the telephone instrument. The telephone exchange, magneto switchboards, common battery switchboards, multiple and "feature" switchboards are then covered in order. A succeeding section of approximately one hundred and seventy-five pages is devoted to automatic switching of the step-by-step type. The eminent fitness of the author to treat this subject is well known in the telephone field. The final chapters are devoted to brief discussions of toll, the phantom circuit, loading of telephone lines, the private branch exchange and measured service.

The text is profusely illustrated and the typographical work is good, although, as is to be expected in a first impression, a few typographical errors have crept in. No doubt these will be eliminated in succeeding impressions. The small-size page, flexible covers and complete index add to its convenience as a book of reference. It can be recommended heartily as a low-priced introductory book on telephone equipment.